Outboard OptiMax I

Technician's Guide

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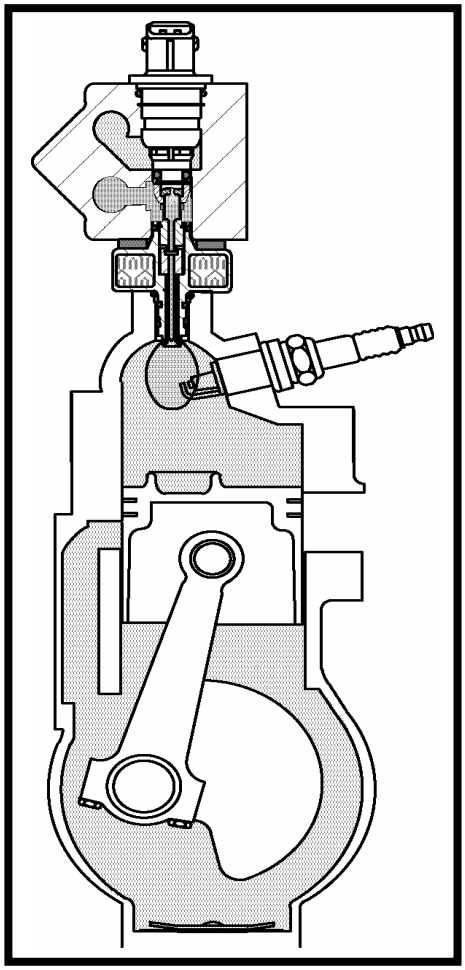

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14 Pin Adapter and Control Harnesses

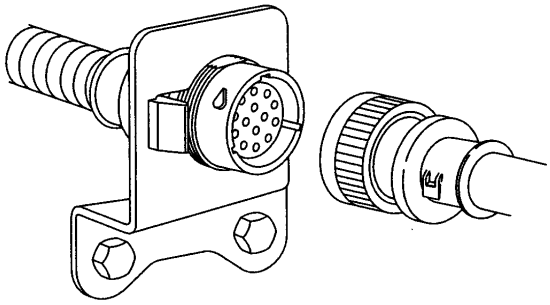
Models Affected

4-stroke models 9.9 thru 225 HP V-6 EFI (Excluding Verado)

2-stroke V-6 Outboards 135 thru 250 HP (Excluding Jet Drive)

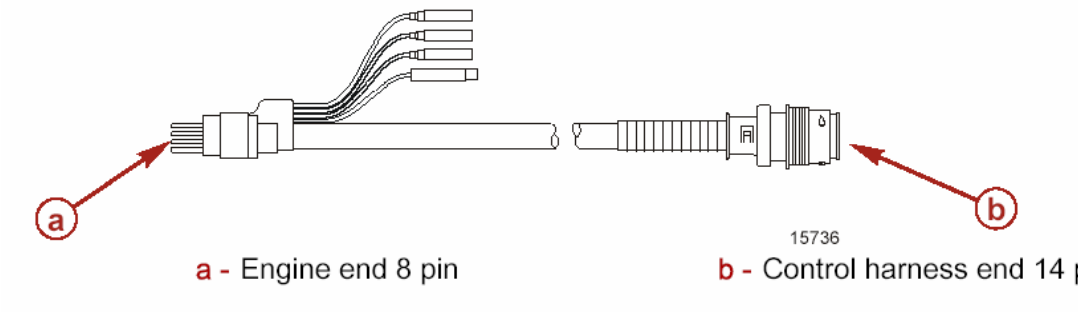
The 2006 models listed above will be changing to a 14 pin connector for the main engine to boat control harness connection. A number of harness adapters have been developed to allow the use of older controls on new engines that use the 14 pin connector. Some of the new adapters will also allow the 2005 and prior models to use the new style 14 pin controls and key/choke harnesses.

- New engine harness requires a new 14 pin key/choke harnesses & controls. CAN # 1 & 3 built into harness with separate terminator locations. Old will NOT supersede to new.
- Reference Current Parts Catalogue for part numbers.



Adapter Harnesses (Key/Choke)

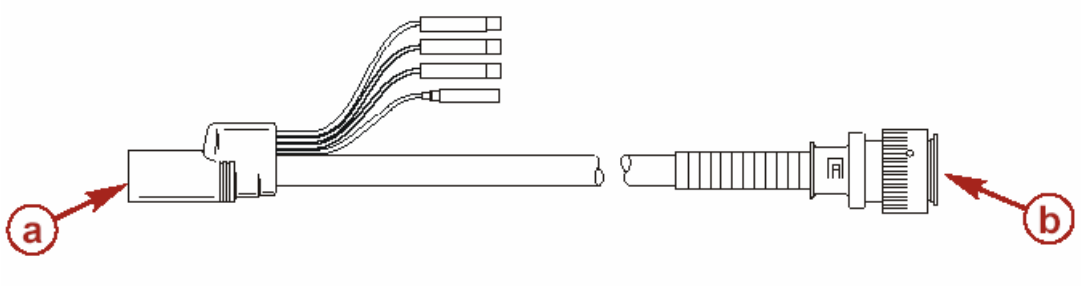
84-896539T_ Adapts 2005 model year and prior engines that use the round 8 pin harness to the new 14 pin key/choke harness. Use with engines not being equipped with SmartCraft gauges.



Notes

Adapter Harness

84-896542T_ Adapts 2006 model year and newer engines that use the 14 pin harness to the old round 8 pin control or key/choke harness. Use with engines not being equipped with SmartCraft gauges.



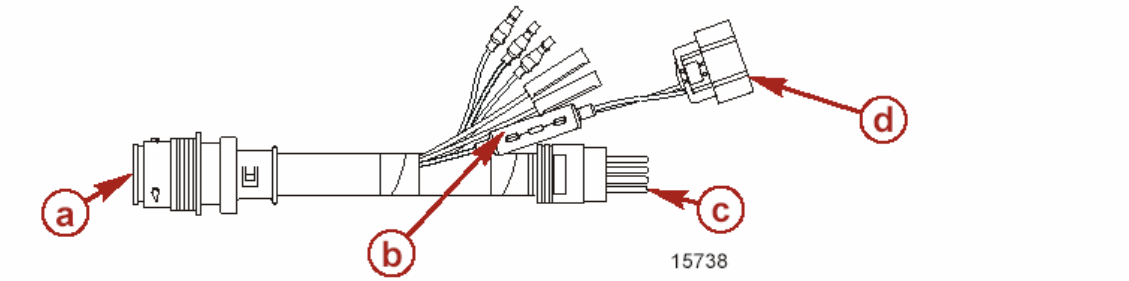
a - Control harness end 8 pin

b - Engine end 14 pin

Adapter Harness

84-892092T_ Adapts 2005 model year and prior engines that use the round 8 pin harness to the new 14 pin control or key/choke harness. Use with engines being equipped with SmartCraft gauges. The adapter allows engine and boat data to be transmitted through the new 14 pin control or key/choke harnesses. The new 14 pin control or key/choke harnesses have connections at the helm for SmartCraft gauges.

Important: A separate blue data harness would longer be required.



a - Control harness end 14 pin

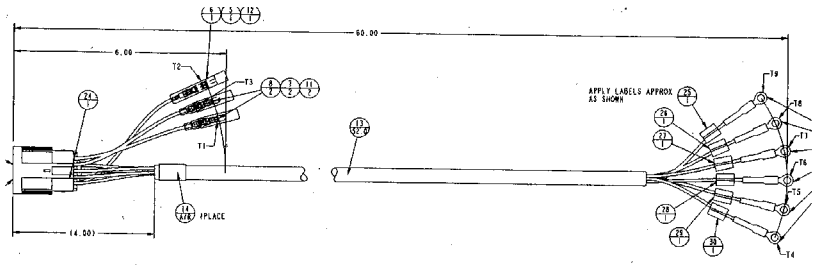
b - Resistor for SmartCraft

c - Engine end 8 pin

d - CAN connection at engine

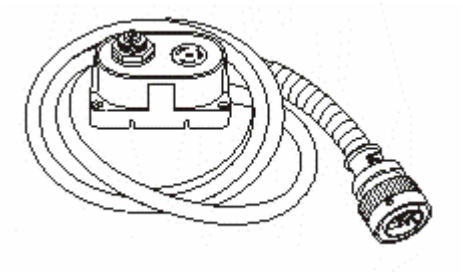
Analog Instrument Harness

84-892990T01 connects to the 10 pin/J-box connection on new 14 pin key/choke harness, to operate analog gauges



New Test Key Switch 14 pin15000A12

Service tool to isolate the boat from the engine.



8 pin Service Key Switch 15000A7

Data Harness Pulling Procedure

IMPORTANT: Do not route data harness near engine ignition components (coils, spark plug leads, and spark plugs), high power VHF coax or radios. An electrical field generated from these components could cause interference with data transmission.

IMPORTANT: Do not route data harness near sharp edges, hot surfaces or moving parts. Fasten cables away from any sharp edges, fasteners or objects that could wear into the harness.

Notes

Notes

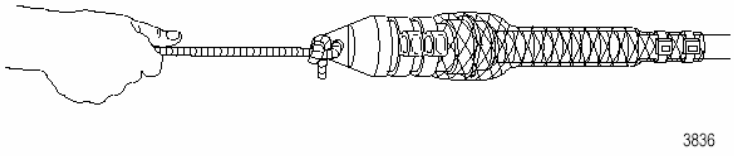
IMPORTANT: Avoid sharp bends in the data harness. Minimum bend radius should be 7.6 cm (3 in.) for the final wiring installation.

1. Inspect the routing path to make sure surfaces are free of any sharp edges or burrs that could cut the harness.

2. Install cable pulling tool to data harness.

3. Secure pulling tool with 2 cable ties.

IMPORTANT: The cables ties must be tight to prevent any slipping during installation.



Data Cable Puller	91-888462A1

IMPORTANT: Carefully inspect data harness pins to ensure all pins are securely fastened to data harness connector end following installation.

NOTE: Data harness should be secured with mounting clips or cable ties along the routing path.

Dielectric Grease

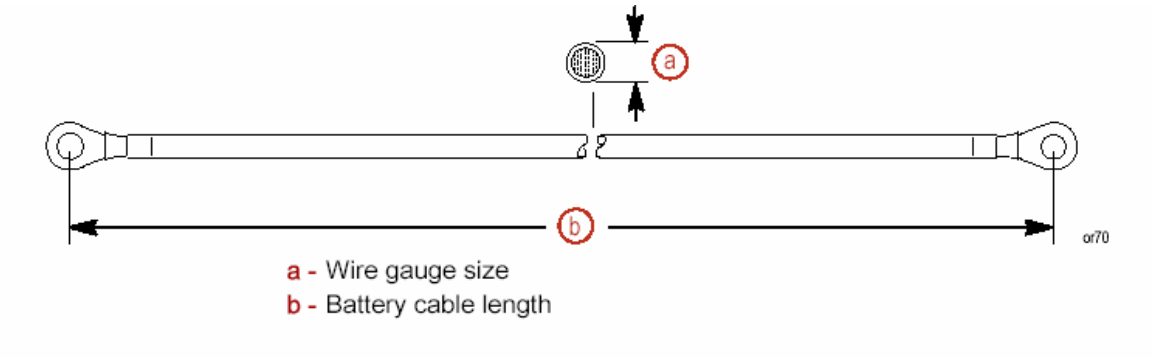
- Dielectric grease will no longer be used on electrical connection except the 8 pin cannon plug on 2005 product Improved electrical connection allows the removal of the grease

Battery Cable Size For Outboard Models

IMPORTANT: Only use copper battery cables. Do not use aluminum cables for any outboard marine installations.

• If longer battery cables are required, the wire gauge size must increase. See chart following for correct wire gauge size.

• DTS L models are equipped with 3.7 m (12 ft.) cables. DTS XL and XXL models are not shipped with battery cables.



a - Wire gauge size
b - Battery cable length

Copper Battery Cable Wire Gauge Size					
Wire Gauge Size Number SAE					
Models		6-25 hp	30-115 hp (except OptiMax)	125-250 hp (except OptiMax)	OptiMax/Verado
Cable Length	2.4 m (8 ft.)	8[1.]	6[1.]	-	-
	2.7 m (9 ft.)	6	4	-	-
	3.0 m (10 ft.)	6	4	6[1.]	-
	3.4 m (11 ft.)	6	4	4	-
	3.7 m (12 ft.)	6	4	4	4[1.]
	4.0 m (13 ft.)	6	2	4	2
	4.3 m (14 ft.)	4	2	4	2
	4.6 m (15 ft.)	4	2	4	2
	4.9 m (16 ft.)	4	2	2	2
	5.2 m (17 ft.)	4	2	2	2
	5.5 m (18 ft.)	4	2	2	2
	5.8 m (19 ft.)	4	2	2	2
	6.1 m (20 ft)	4	2	2	2
	6.4 m (21 ft.)	2	1	2	1
	6.7 m (22 ft.)	2	1	2	1
	7.0 m (23 ft.)	2	1	2	1
	7.3 m (24 ft.)	2	1	2	1
	7.6 m (25 ft.)	2	1	2	1
	7.9 m (26 ft.)	2	1/0	1	1/0
	8.2 m (27 ft.)	2	1/0	1	1/0
	8.5 m (28 ft.)	2	1/0	1	1/0
	8.8 m (29 ft.)	2	1/0	1	1/0
	9.1 m (30 ft.)	2	1/0	1	1/0
	9.4 m (31 ft.)	2	1/0	1	1/0
	9.8 m (32 ft.)	2	1/0	1	1/0
	10.1 m (33 ft.)	2	2/0	1/0	2/0
	10.4 m (34 ft.)	2	2/0	1/0	2/0
	10.7 m (35 ft.)	1	2/0	1/0	2/0
	11.0 m (36 ft.)	1	2/0	1/0	2/0
	11.3 m (37 ft.)	1	2/0	1/0	2/0
	11.6 m (38 ft.)	1	2/0	1/0	2/0
	11.9 m (39 ft.)	1	2/0	1/0	2/0
	12.2 m (40 ft.)	1	2/0	1/0	2/0

1. Standard (original) cable length and wire gauge size.

Notes

Battery Information All OptiMax

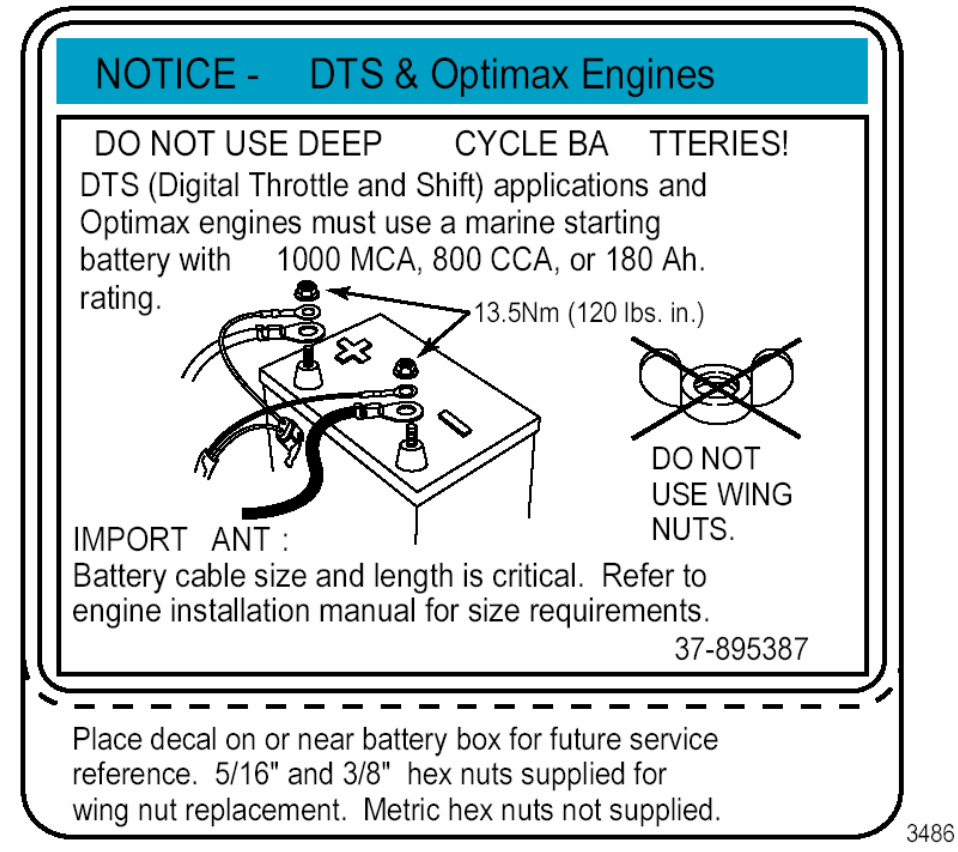
• Do not use deep cycle batteries. Engines must use a marine starting battery with 1000 MCA, 800 CCA or 180 Ah.

• When connecting engine battery, hex nuts must be used to secure battery leads to battery posts. Torque nuts to specification.

DTS Battery Installation

Description	Nm	lb. in.	lb. ft.
Hex nuts	13.5	120	

IMPORTANT: Battery cable size and length is critical. Refer to engine installation manual for size requirements. Decal needs to be placed on or near battery box for future service reference. One 5/16 in. and one 3/8 in. hex nut are supplied per battery for wing nut replacement. Metric hex nuts are not supplied.

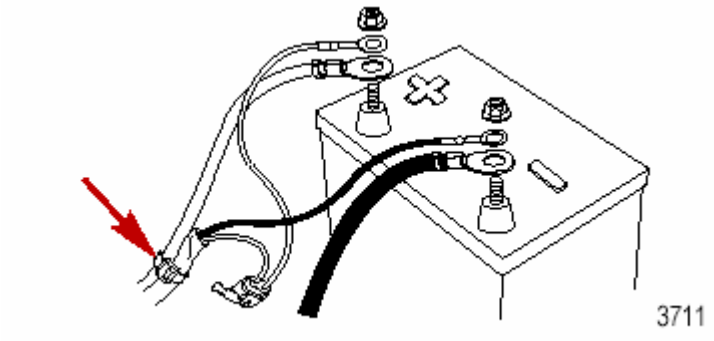

NOTICE - DTS & Optimax Engines
DO NOT USE DEEP CYCLE BA TTERIES!
DTS (Digital Throttle and Shift) applications and Optimax engines must use a marine starting battery with 1000 MCA, 800 CCA, or 180 Ah. rating.
13.5Nm (120 lbs. in.)
DO NOT USE WING NUTS.
IMPORT ANT :
Battery cable size and length is critical. Refer to engine installation manual for size requirements.
37-895387
Place decal on or near battery box for future service reference. 5/16" and 3/8" hex nuts supplied for wing nut replacement. Metric hex nuts not supplied.
3486

Connecting Battery Cables and DTS Power Harness

⚠ CAUTION

To avoid the possibility of loss of electrical power due to the DTS power harness connection being pulled off battery, fasten the DTS power harness to one of the battery cables near the battery with cable tie.

- Install DTS power harness directly to the starting battery only.
- Do not extend lead length of harness.
- See accessory manual for optional lead connection kit.



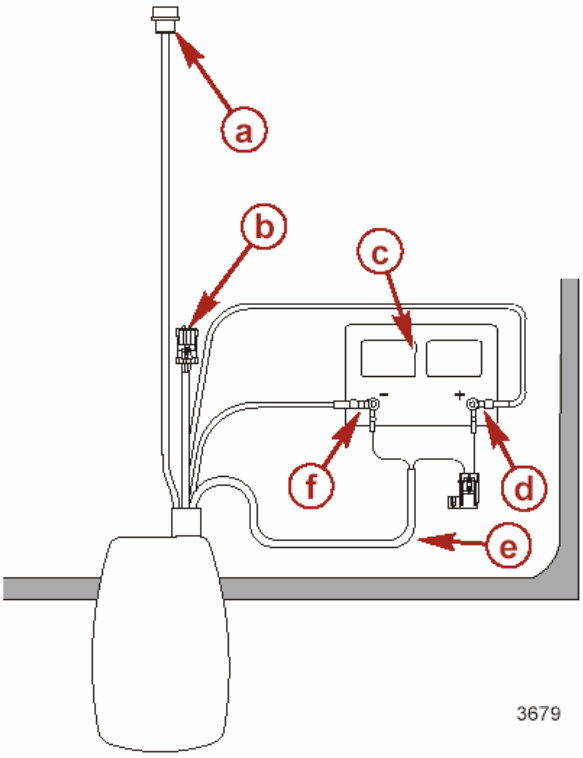
System Wiring Reference Points DTS

- DTS power harness - Provides 12V power to the DTS system. Requires connection to the starting battery. If starting battery is located at the helm, DTS power harness accessory kit is required to minimize voltage drop. Use cable ties to secure power harness leads to battery cables, beginning within 15 cm (6 in.) of battery posts and continuing along the entire length of the harness.
- Battery cables - Connect to the starting battery.
- Vessel sensor harness - This harness connects to the main fuel tank sensor, auxiliary fuel tank and the paddle wheel speed/temperature sensor, if equipped.

Notes

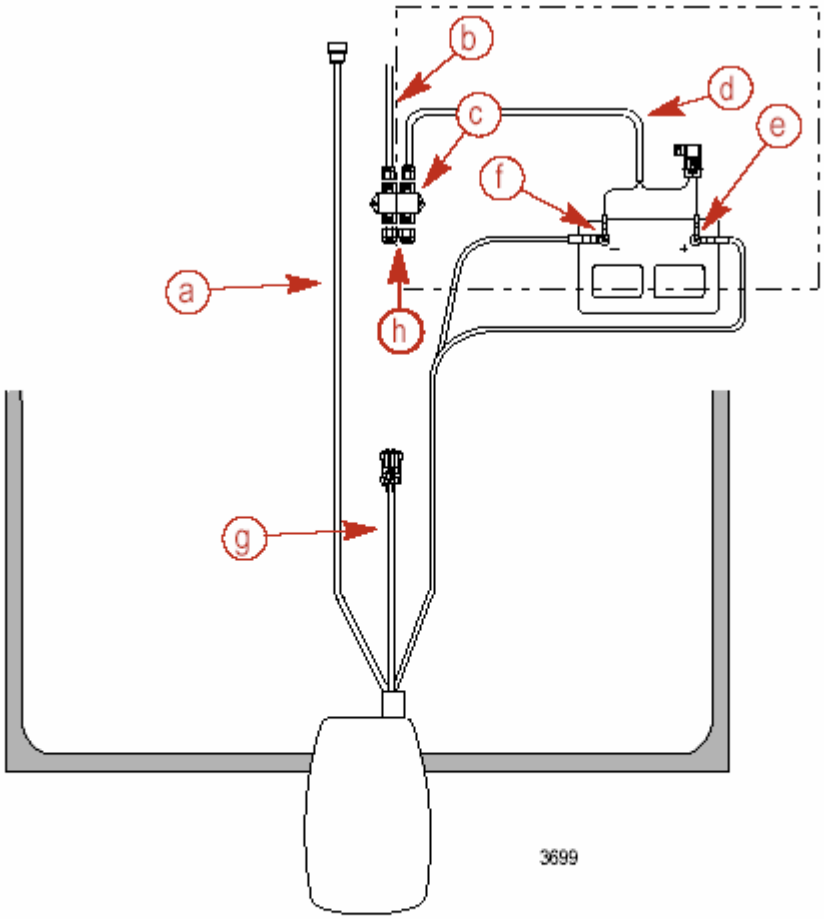
Notes

Single Engine - Battery At Stern



a - 14 pin DTS data harness
b - Vessel sensor harness
c - Battery
d - Red sleeve (positive)
e - DTS power harness (provided)
f - Black sleeve (negative)

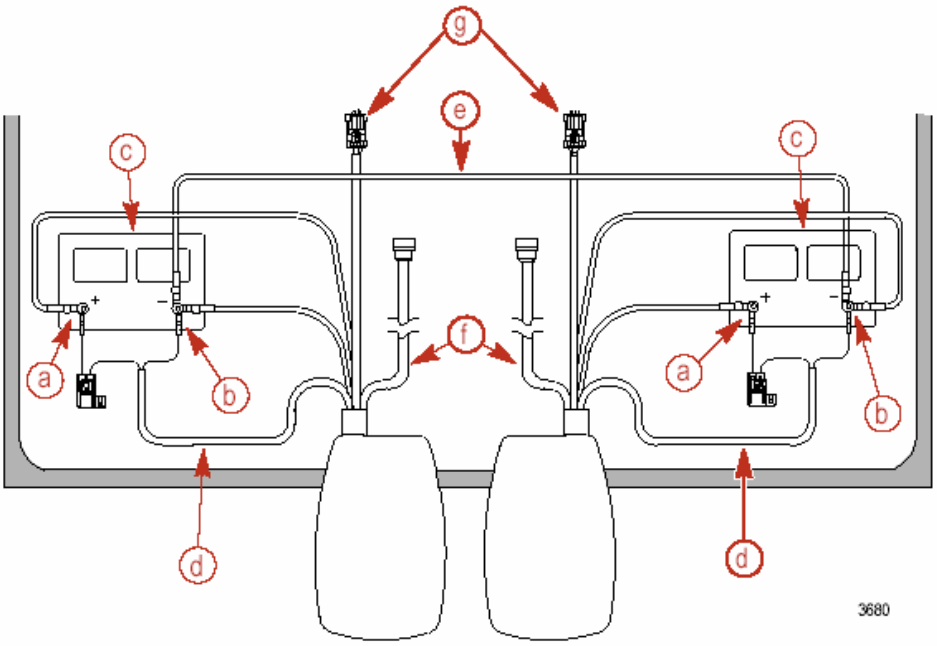
Single Engine - Battery At Helm



a - 14 pin data harness
b - DTS command module harness
c - Junction box
d - Helm DTS power harness (optional)
e - Red sleeve (Positive)
f - Black sleeve (Negative)
g - Vessel sensor harness
h - Weather caps

Notes

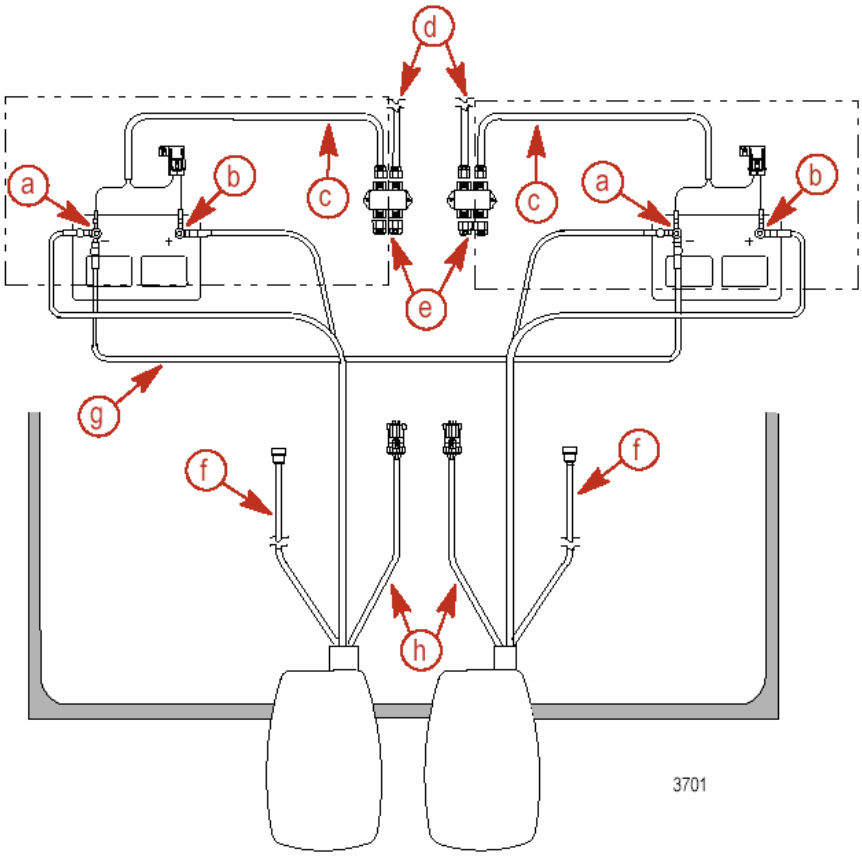
Dual Engine - Battery At Stern



a - Red sleeve (positive)
b - Black sleeve (negative)
c - Battery
d - DTS power harness (provided)
e - Ground cable
f - Data cable
g - Vessel sensor harness

Important: Make sure twin applications have the common ground. If missing can result in open DTS fuse and configuring problems

Dual Engine - Battery At Helm



a - Black sleeve (negative)
b - Red sleeve (positive)
c - Helm DTS power harness (optional)
d - DTS command module harness
e - Junction box weather caps
f - 14 pin data harness
g - Ground cable
h - Vessel sensor harness

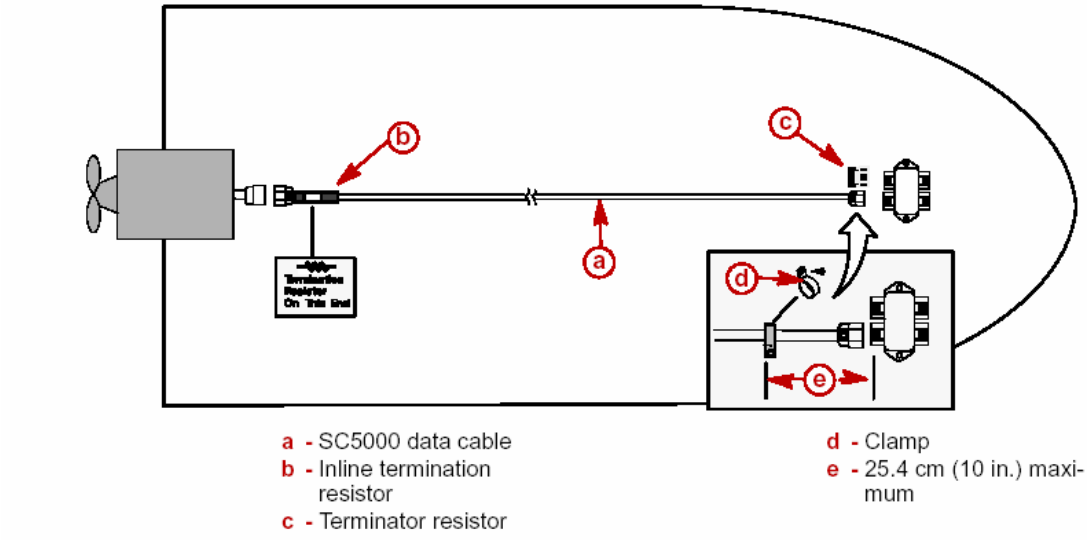
Important: Make sure twin applications have the common ground. If missing can result in open DTS fuse.

Notes

Connecting 04 DTS 10 Pin Data Harness Single Engine

Single Helm

- SC5000 data cable (yellow) with termination resistor at engine end is required.
- Install termination resistor in the junction box.
- Fasten cable connections within 25.4 cm (10 in.) of the junction box.

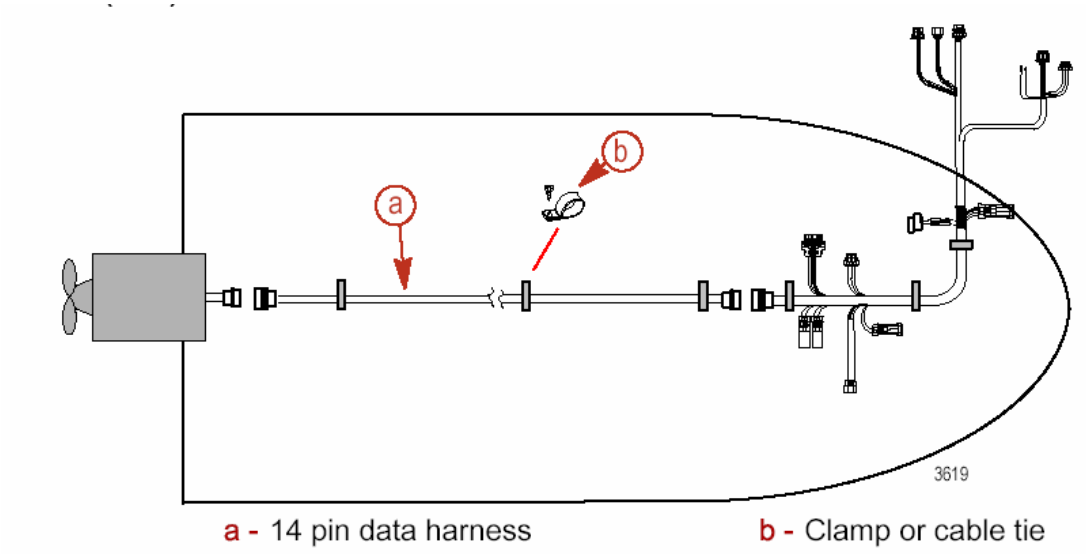


a - SC5000 data cable
b - Inline termination resistor
c - Terminator resistor
d - Clamp
e - 25.4 cm (10 in.) maximum

Connecting 14 Pin Data Harness - Single Engine

Single Helm

IMPORTANT: Avoid sharp bends in the harness. Minimum bend radius should be 7.6 cm 3 inches.



a - 14 pin data harness
b - Clamp or cable tie

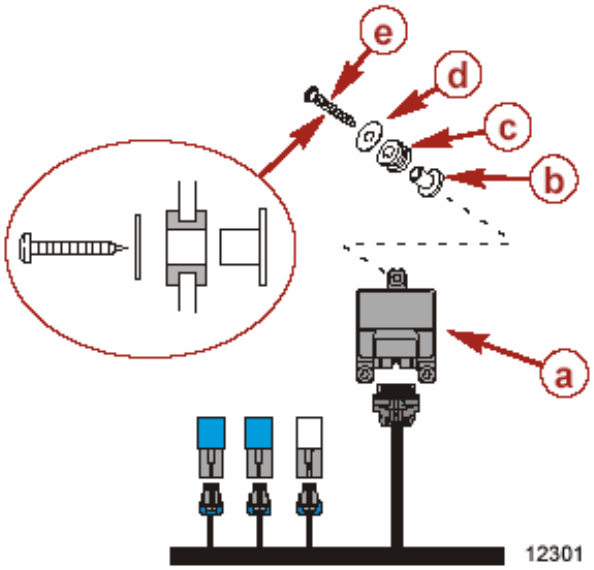
Command Module Installation

1. Plug the command module connector into the command module.

2. To minimize vibration, mount the command module with the supplied rubber grommets/bushings according to the following guidelines:

- Mount in an area that is accessible
- Mount in an area where the wiring connections will not be stepped on or disturbed
- Mount with the Command Module connector facing down to prevent water intrusion.
- Fasten the command module harness to prevent flexing at the command module connection.

IMPORTANT: Avoid sharp bends in the cable. The minimum bend radius should be7.6 cm (3 in.).



a - Command module connector down prevent water intrusion
b - Bushing
c - Grommet
d - Washer
e - Screw

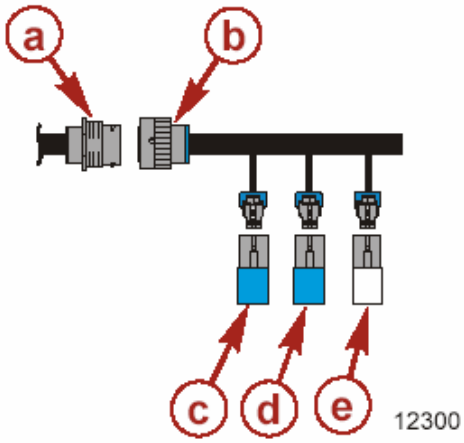
Notes

Notes

Single Helm Command Module Harness Installation

1. Connect the 14 pin Deutch connector on the command module harness to the 14 pin data harness.

2. Ensure the CAN 1 and CAN 2 connectors have terminator resistors installed, and the CAN 3 connector is sealed with a weather cap.



a - 14 pin data harness (from engine)
b - Helm 1 command module harness
c - CAN 1 (blue and white) - terminator
d - CAN 2 (brown and yellow) - terminator
e - CAN 3 (orange and green) - weather cap

CAN 1	Gauges and back up for DTS
CAN 2	DTS data communication
CAN 3	Vessel Systems (Racing trim tabs) inputs

DTS Command Module History

IMPORTANT: DTS Command Modules must not be intermixed with different model year DTS Command Modues. The model year of the command module must match the model year of the PCM calibration.

Model Year PCM Calibration	CDS "DTS CMD MOD Info" screen
2004 (Yellow 10-pin CAN cable)	"0" Version
2005 (Black 14-pin CAN cable)	"6X" (61-69) Version
2006 (Black 14-pin CAN cable)	"7X" Version

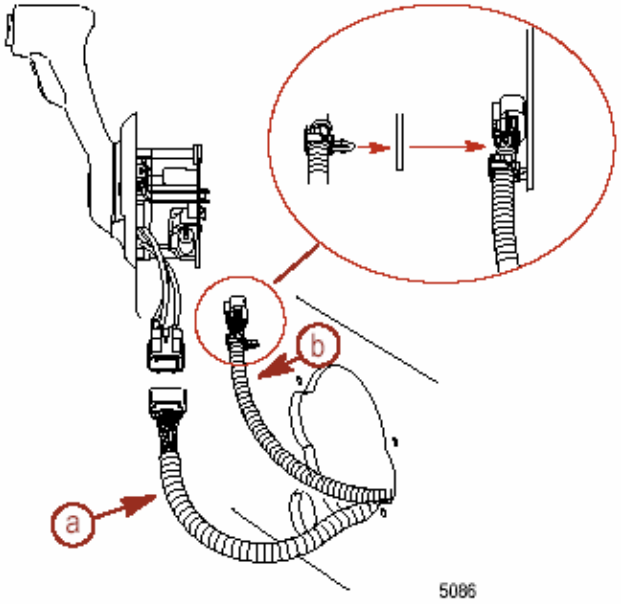
Panel Mount Control Wiring Connections

1. Connect the trim harness and lever harness.

2. Insert the bayonet end of the lever harness into the bracket hole. This will prevent the connector from pulling out. See illistration below

3. Connect the lanyard stop switch bullet connectors.

IMPORTANT: Allow slack in the trim harness. Harness will flex and move during control handle movement.



a - Trim harness b - Lever harness

DTS Wiring Guidelines

⚠ WARNING

To avoid the possibility of serious injury or death from loss of boat control, do not splice or probe into any wire insulation of the DTS system. Splicing or probing will damage the wire insulation allowing water to enter the wiring. Water intrusion may lead to wiring failure and loss of throttle and shift control.

- Never attempt to connect, network, tie into, switch, and/or sink source voltage or current from the DTS wiring harnesses.
- Never attempt to connect any type of communication or navigation equipment into the DTS wiring harnessing other than at the designated connection point.
- Boat accessory equipment being installed must be connected to an appropriate power source such as a fuse panel or junction block.
- Never attempt to tap directly into any of the DTS electrical wiring harnesses for a source of power.

Notes

Notes

Wiring Guidelines for Electrical Boat Accessories

⚠ WARNING

To avoid the possibility of serious injury or death from loss of boat control, do not wire any electrical accessory into the 12 volt ignition key switch circuits of the DTS system. A voltage drop caused by an electrical accessory connected to the ignition key switch circuit may lead to loss of throttle and shift control.

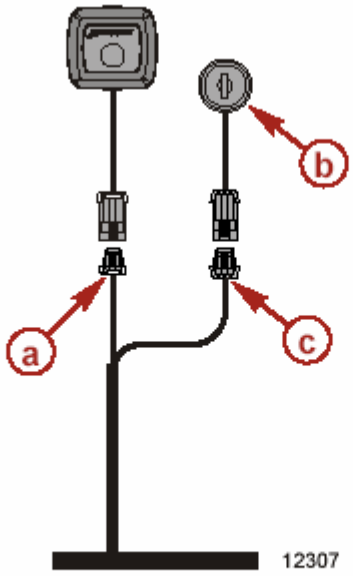
IMPORTANT: Do not connect boat accessories to 12 volt or ignition key switch DTScircuits. Use a separate switched 12 volt source for wiring boat accessories. The DTS system requires a consistent 12 volt power source. Splicing or connectingaccessories to the 12 volt or ignition key switch DTS circuits (purple, purple/white, or red wires) could blow a fuse or overload circuits, causing intermittent or complete loss of operation.

Harness Installation Guidelines

- Locate a routing path for the harness connections so they reach their installation points.
- Inspect the routing path to make sure surfaces are free of any sharp edges or burrs that could cut the harness.
- Fasten and support the harness with clamps or cable ties along the routing path. A clamp or cable tie must be used within 25.4 cm (10 in.)of any connection in a DTS system.
- Ensure all connections are tight and seal all unused connectors with weather caps.

Key Switch Wiring Connections

1. Install the ignition key switch. Refer to the installation instructions which are provided with the key switch.
2. Connect the key switch to the harness as shown.



a - Start/stop switch connection
b - Key switch
c - Key switch connection

Key Switch Options

• Key Switch Three Position (Off, Run, and Start) has shorter key and mounting length 3/4 inch cut out. Without mounting hardware. Can be used on DTS as well as Non DTS installations. Fits up to 1/2 inch thick dash boards.

• Key Switch Four Position (Off, Accessory, Run and Start). 7/8 cut out. Without mounting hardware. Can be used on DTS as well as Non DTS installations.

• Key Switch Kit- Four Position includes key switch, key cover, bezel 2 1/8 diameter mounting housing adaptor and mounting hardware 7/8 cut out.

Notes

Notes

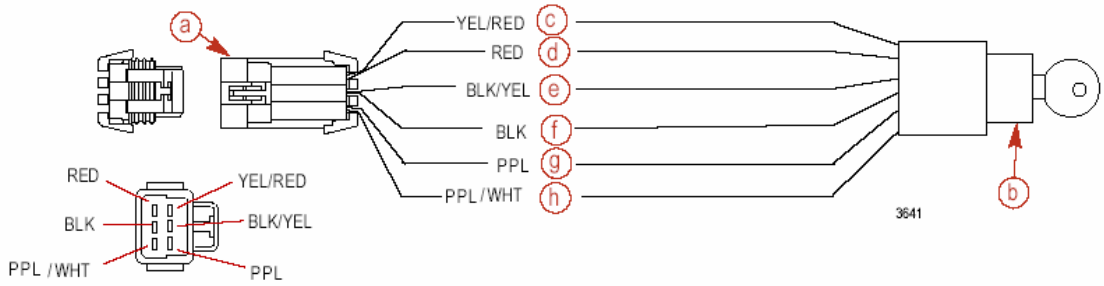
Wiring Instructions for Non-Mercury Marine Ignition Key Switch

NOTICE
Mercury Marine strongly recommends that boat builders and dealers use only Mercury Marine brand SmartCraft and DTS accessories. The throttle and shift functions on a boat are safety critical components. Mercury Marine validated the design and manufacture of the various SmartCraft and DTS accessories sold by Mercury Marine through an extensive product qualification testing protocol. Each of the Mercury Marine accessories for these systems has passed through that qualification process. It is not possible for Mercury Marine to test its systems with all of the accessories manufactured and sold by other entities. As a result, if a boat builder or dealer chooses to disregard the recommendation that only Mercury Marine accessories be used, the boat builder or dealer should adhere to specifications provided by Mercury Marine for all non-Mercury Marine components which interface with the Mercury Marine SmartCraft and/or DTS System. Documentation exhibiting compliance with these specifications should be submitted and approved by Mercury Marine prior to the finished product being released for sale. The Mercury Marine Limited Warranty does not provide coverage for damage caused by the use of accessories or parts not manufactured or sold by Mercury Marine.

⚠ CAUTION
Prevent unexpected engine start-up. Non-Mercury Marine ignition switches may allow sufficient current leakage to cause engine to start unexpectedly.

• The ignition key switch must comply with Mercury specifications for key switches and controller input switches (897741-5 or 897791-5). Switches that do not meet these specifications could leak current.

- Switches must contain an emergency stop circuit.



a - Connector - Packard Metripack 150 Series sealed (6 pin)
b - Ignition key switch
c - Crank
d - +12 volts
e - Lanyard stop
f - Ground
g - Run
h - Accessory

DTS Configuration and Adaptation Methods

- System View version 3.44 or greater for 06 DTS Systems.
- System View version 3.42 or greater for 05 DTS Systems.
- System View version 3.33 or greater for 04 DTS Systems Single engine and helm only.

• For instructions reference SmartCraft DTS Service Manual pertaining to specific DTS system model year.

• CDS version 5.09 or higher for 06 DTS System

• CDS version 3.23 or higher for 05 DTS System

• CDS version 3.12 or higher for 04 DTS System

• For step by step instructions reference the Help Icon (purple book with question mark) on top row of CDS.

Important: CDS requires CAN cable 84-892663

Typical SmartCraft Installation Configurations Non DTS OptiMax 2000-2005

Question: How do you tell the difference between the current Smart Tach and Speedo and the new System Tach and Speed?

Answer: The new System Tach and Speed will have a blue back. It also has the SmartCraft logo on the dial face, the background is one color and it has what we call “eyebrows”.

a - Logo
b - Eyebrow
c - Blue Back Cover

Notes

TERMINATION RESISTOR PLACEMENT

NOTE: Termination resistors are designed to reduce noise and provide proper DC voltage levels on the C.A.N. Bus circuit.

1. Each system must include exactly two (2) termination resistors.

2. Termination resistors must be located at the furthest ends of the main C.A.N. Bus trunk.

3. The main C.A.N. Bus trunk may not exceed 36.6 m (120 ft.) in length (measured along the cable). Main C.A.N. Bus Trunk is defined as the length of cable located between termination resistors.

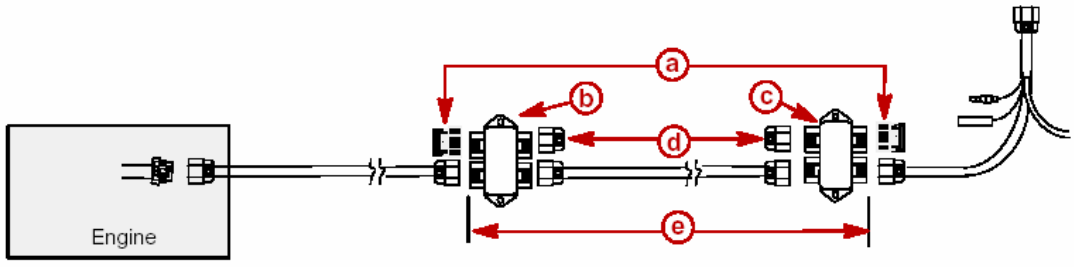
There are three (3) acceptable methods of adding termination resistors to the system.

1. Junction box termination resistors.

2. Termination resistor inside the harness with a termination resistor at the junction box.

3. Termination resistor inside the harness at both ends.

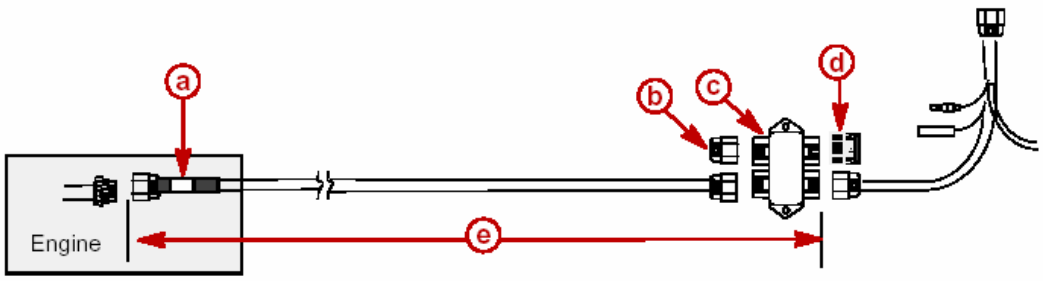
NOTE: Junction box termination resistors are designed to plug directly into junction box ports.



a - Termination resistors (859318T1)
b - Junction box located at rear of boat
c - Junction box located at dash
d - Weather cap (859318T2)
e - Main C.A.N. Bus trunk

Harness Termination Resistor (One End)

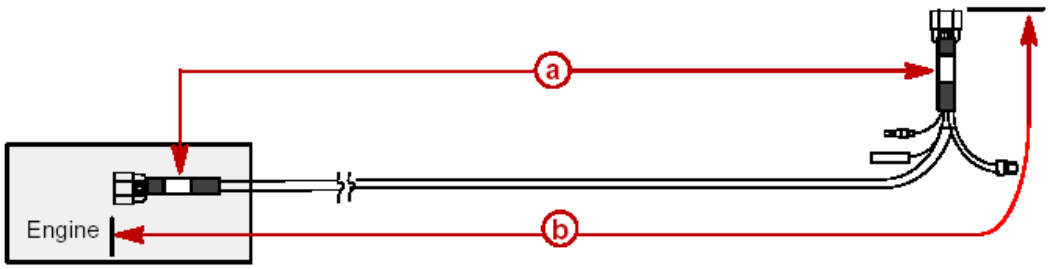
Some of the SmartCraft wiring harnesses (84-879981T_) are designed with the termination resistor at one end. Harness termination resistors are used primarily for installations which do not require a junction box in the rear of the boat.



a - Harness termination resistor at engine
b - Weather cap (859318T2)
c - Termination resistor (859318T1)
d - Junction box located at dash
e - Main C.A.N. Bus trunk

Harness Termination Resistor (Both Ends)

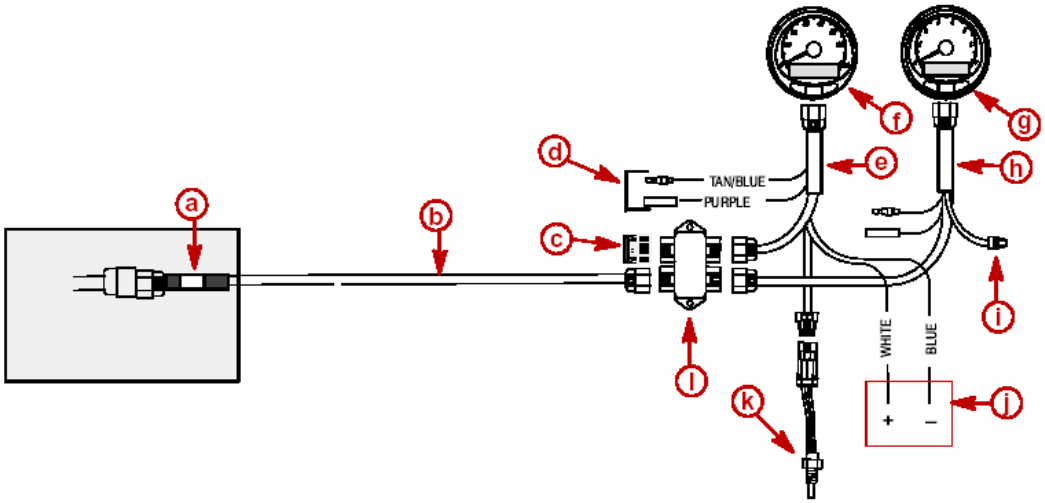
Harness (84-879982A20, 30) include termination resistors at both ends and may be used to connect System Monitor or System tachometer directly to the engine without junction boxes.



a - Termination resistor
b - Main C.A.N. Bus trunk

Notes

System Tachometer/Speedometer Wiring Configurations



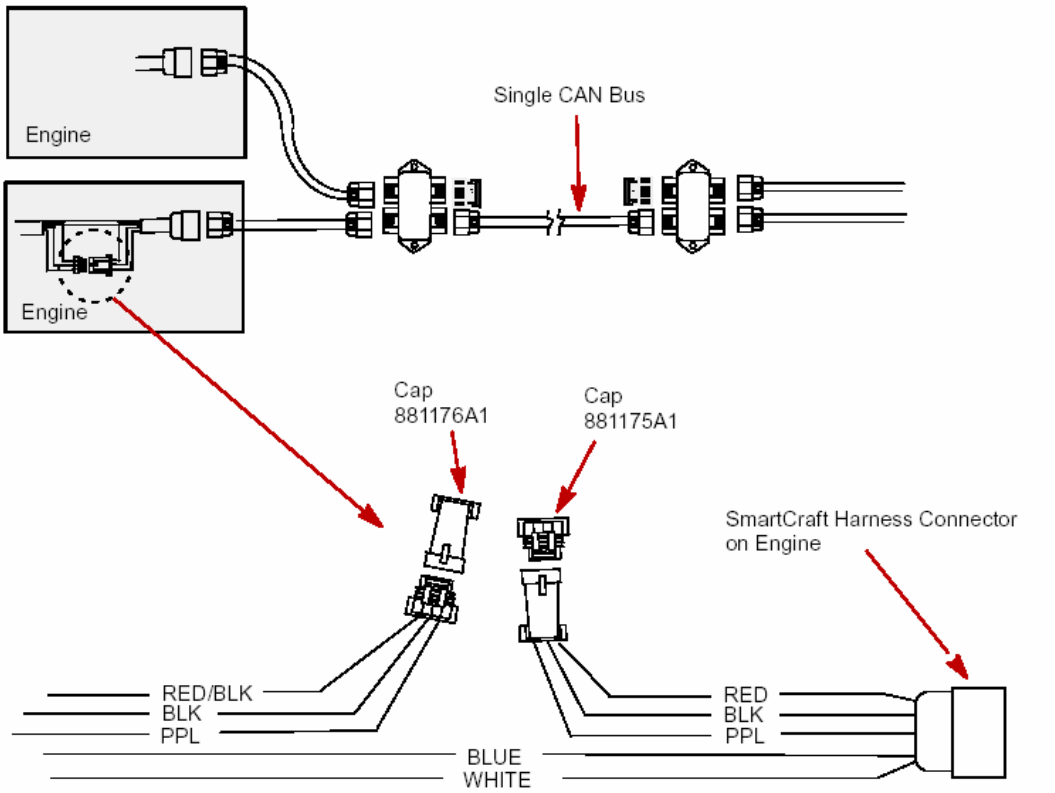
a - Termination resistor
b - Harness (84-879981T_)
c - Termination resistor (859318T1)
d - Warning horn connection
e - Speedometer harness (84-879978T1)
f - Speedometer (79-879897K11)
g - Tachometer (79-879899K13)
h - Tachometer harness (84-879979T1)
i - System Link connection
j - NMEA GPS connection
k - Air Temperature sensor (56-820386A76)
l - Junction box (878492 4)

Dual Engine

IMPORTANT: The location of the junction box termination resistors are critical forproper system function. All unused junction box ports must be sealed with a weathercap. Disconnect the power harness on the port engine.

If running a single CAN bus (blue data cable) on dual or more engine installations, only one engine is used to supply 12 volt power. On the remaining engines, disconnect the 3 wire CAN power harness under the cowl as shown below. This connector is about 3 inches from the under cowl SmartCraft data cable (blue boat cable) connection. Plug the connectors with caps as shown.

NOTE: Engine electrical damage may result if more than one engine powers this system. A failure of this nature is not covered under normal engine warranty.



NOTE: *If separate CAN Bus cables are used to connect to the gauges, on multiple engin applications, it is not necessary to disconnect the internal 12V harness.*

Notes

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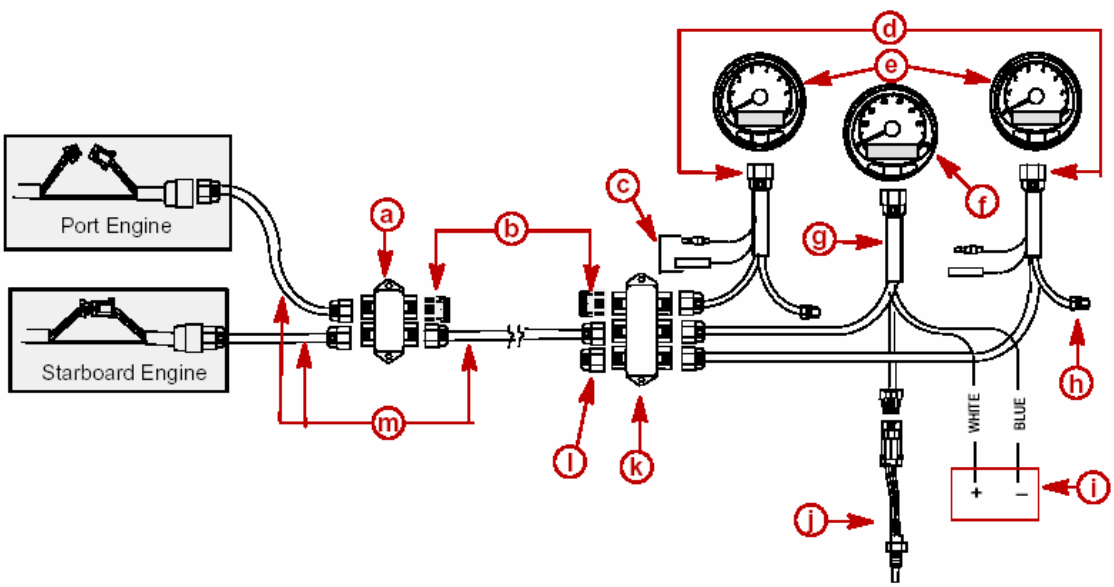


a - Junction box mounted at rear (878492 4)
b - Termination resistor (859318T1)
c - Warning horn connection
d - Tachometer harness (84-879979T1)
e - Tachometer (79-879897K11)
f - Speedometer (79-879899K13)
g - Speedometer harness (84-879978T1)
h - System Link connection
i - NMEA GPS connection
j - Air Temperature sensor (56-820386A76)
k - Junction box (878492 6)
l - Weather cap (859318T2)
m - Harness (84-879968T_)

IMPORTANT: When using single CAN line make sure to disconect one 8 pin power connector.

Note: For other SmartCraft configurations reference current Outboard Rigging Guide.

Analog Gauge Connections for Digital Optimax Models Bulletin 2000-11

- 2001 Model Year
- 135 thru 225 Optimax
- S/N 0T178500 and Above

The 2001 Optimax engines are no longer built in Analog and Digital versions. The new models are primarily set up for Digital gauge connections. If analog gauge connections are required, use the following instructions.

Installing Standard Analog Tachometer to Digital Optimax Engines

This procedure allows a standard analog tachometer to be connected to the tachometer plug that is incorporated into the key switch harness.

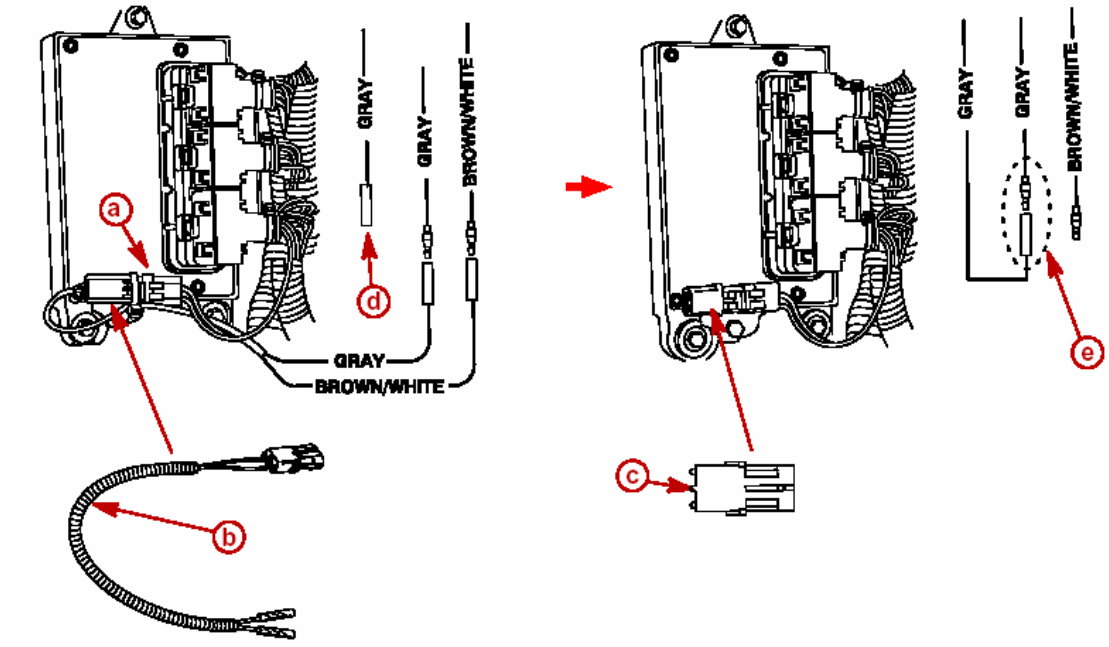
NOTE: SmartCraft speedometer or tachometer communicate with the engine through the gray lead and the brown/white lead in the key switch harness. This procedure uses one of these leads to operate the tachometer and breaks the connection between the SmartCraft gauges and the engine. SmartCraft gauges will not function with an analog tachometer connected. The System Monitor, Speedometer and Tachometer communicate with the engine through a dedicated 10 pin connection on the engine. Using this procedure to install an analog tachometer will not effect the operation of the System Monitor, speedometer or tachometer.

1. Locate the diagnostic port plug mounted on the ECM. Remove and discard the diagnostic harness from the port plug.

2. Install cover P/N 832948A1 on the port plug.

3. Locate the gray (tachometer signal) wire in the engine wiring harness. and remove the rubber plug. Connect the gray wires together.

4. Connect tachometer to the tachometer plug using tachometer harness P/N 84-86396A8.



a - Diagnostic Port Plug
b - Diagnostic Harness
c - Port Plug Cover (P/N 832948A1)
d - Gray (Tachometer Signal) Wire
e - Connect Gray Wires Together

Note: Diagnostic harness (b) is no longer standard on engines.

Notes

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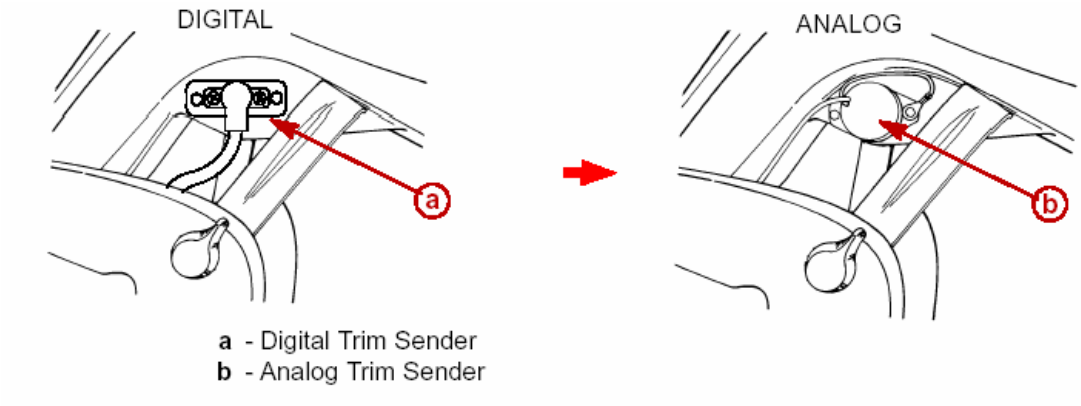
Installing Standard Analog Trim Indicator Gauge to Digital Optimax Engines

NOTE: SmartCraft speedometer or tachometer communicate with the engine through the gray lead and the brown/white lead in the key switch harness. This procedure uses one of these leads to operate the Trim Gauge and breaks the connection between the SmartCraft Gauges and the engine. SmartCraft gauges will not function with an analog Trim Gauge connected.

The System Monitor, Speedometer and Tachometer communicate with the engine through a dedicated 10 pin connection on the engine. Using this procedure to install an analog trim gauge will not interfere with the operation of the System Monitor, speedometer or tachometer.

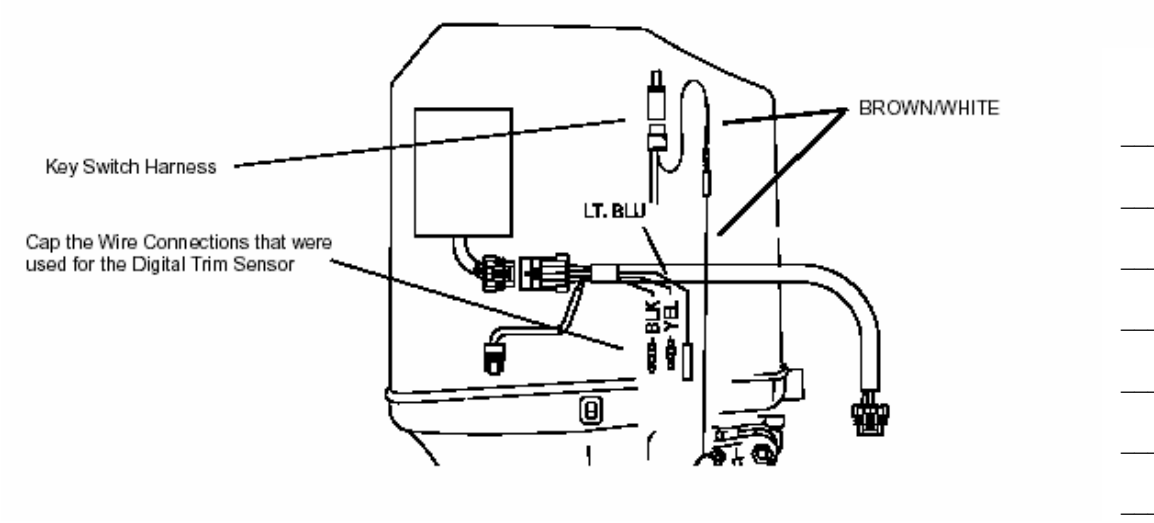
However, the digital trim sender must be removed to install the analog trim sender. The removal of the digital trim sender will eliminate any trim information from being displayed on System Monitor, speedometer or tachometer.

1. Tilt the outboard up and engage the tilt support lever.
2. Remove the digital trim sender assembly. Retain screws for reassembly.
3. Install analog trim sender P/N 821180A6 as shown. Route and fasten the wiring harness at the same locations as the old harness.



a - Digital Trim Sender
b - Analog Trim Sender

4. Connect the Brown/White wire from the trim sender to the brown/white wire extending from the key switch harness.
5. Cap the digital trim sender wires that remain in the engine harness. Use 2 female bullet caps P/N 13540 and 1 male bullet cap P/N 13541.
6. Connect trim indicator gauge to the tachometer plug on the key switch harness using tachometer harness P/N 84-86396A8.



NOTE: If none of the digital sensors (oil level, fuel level, paddle wheel, speedo, and trim) are used, digital harness P/N 84-859244T1 could be removed from the engine. The 8-pin connection on the engine should then be capped with P/N 877613A1.

Installing Standard Analog Temperature Gauge to Digital Optimax Engines

1. Remove the 2 wire temp sender from the air compressor and install 4 wire temp sender P/N 13536A14.

2. Install wire harness P/N 84-88824A4 between the 4 wire temp sender (tan/blue) wire and the tan wire extending from the key switch harness.

3. The ground wire (Black) on the 4 wire temp sender should be installed under the temp sender retainer bolt.

NOTE: Harness P/N 84-88824A4 is the single Tan wire which is normally supplied with the gauge. The eyelet connector will need to be removed, wire cut to length and a bullet connector installed at one end. Available later this year will be harness P/N 84-11149A50 which has a single tan wire with a bullet connectors at both ends. Using this procedure to install an analog temperature gauge will not effect the operation of the System Monitor or any of the SmartCraft speedometer or tachometer functions.

NOTE: Starting with the serial numbers listed below, the 4-wire temp. sender, and TAN wire have been installed on the outboard at the factory.
Replacement of the temp. sender and addition of the TAN wire are NOT required, to connect analog temp gauge.
S/N 0T280001 3.0 Liter
S/N 0T275885 2.5 Liter

Notes

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Installing Standard Speedometer Gauge to Digital Optimax Engines

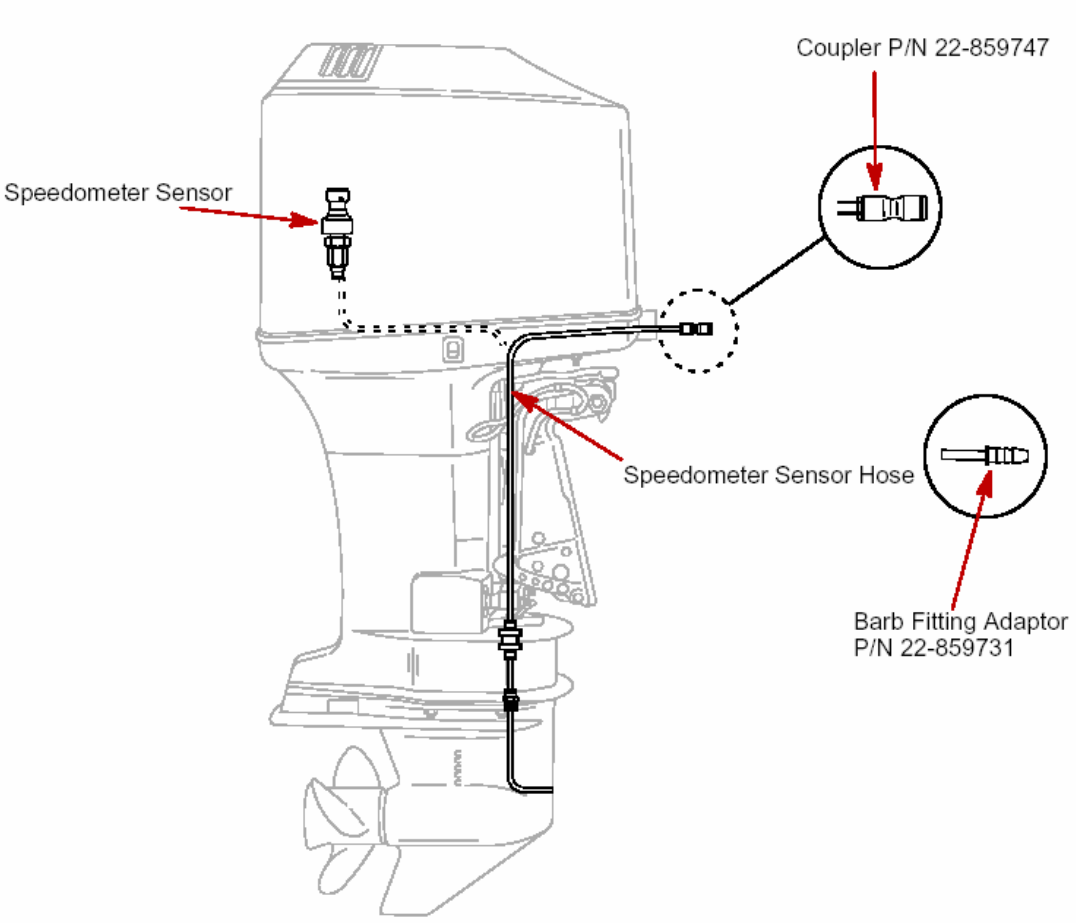
NOTE: The digital speedometer sensor must be disconnected to connect the analog speedometer. The removal of the digital speedometer sensor will eliminate speed information from being displayed on System Monitor and the SmartCraft speedometer or tachometer gauges.

1. Remove the speedometer pressure hose (black) from the speedometer sensor.

NOTE: Coupler connection will be inside the cowl on 200/225 Hp models.

2. Install coupler P/N 22-859747 on the end of the speedometer hose, this will allow a direct connection of later style Mercury speedometer.

NOTE: If older Mercury or after market speedometer is used, barb fitting adapter P/N 22-859731 must be installed into the coupler.

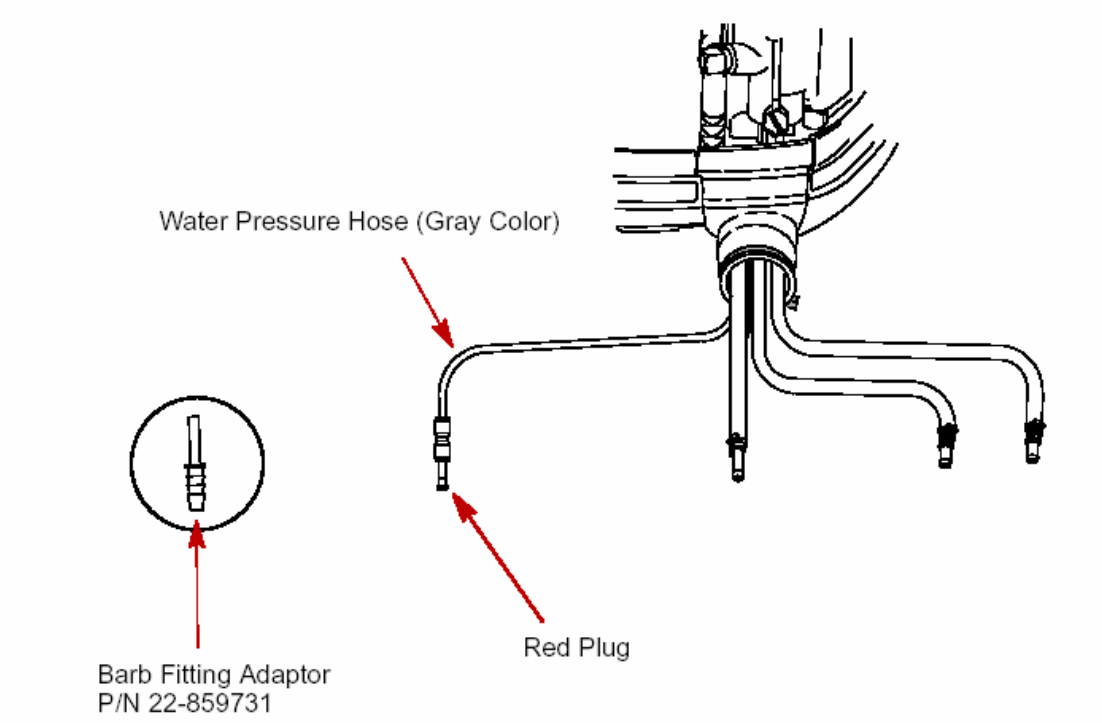


Rigging kit P/N 881120A1 includes all the parts outlined in this Advisory to connect analog gauges to the engine, except the 4 wire temperature sensor P/N 13536A14 and the TAN temperature sensor connector wire P/N 84-88824A 4.

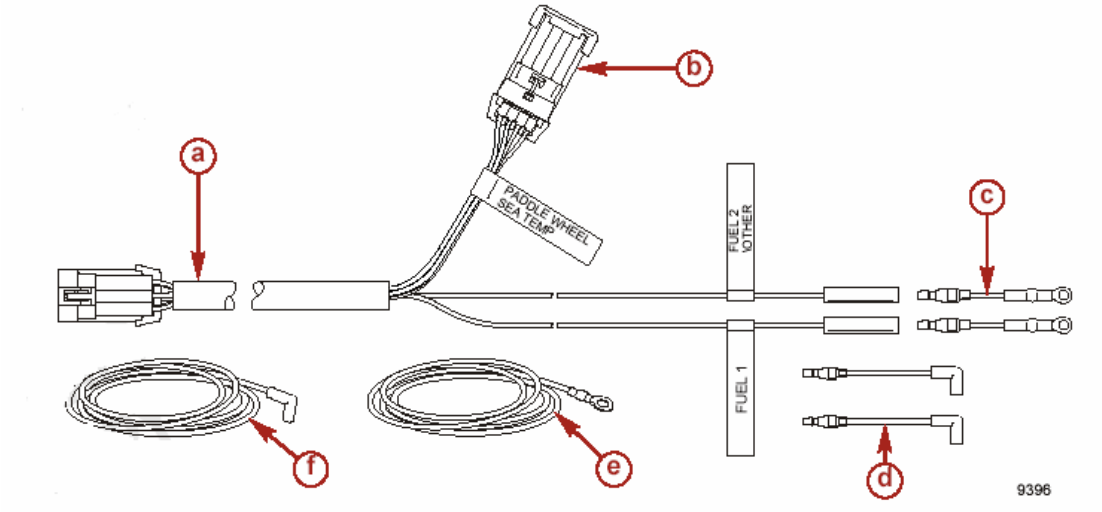
Installing Standard Water Pressure Gauge to Digital Optimax Engines

1. Remove the RED plug P/N 22-859732 from the connector at the end of the water pressure hose (gray color). This will allow a direct connection of later style Mercury water pressure gauge.

NOTE: If older Mercury or after market water pressure gauge is used, barb fitting adapter P/N 22-859731 must be installed into the coupler.



SmartCraft Boat Sensor Harness 84-865891T03



Notes

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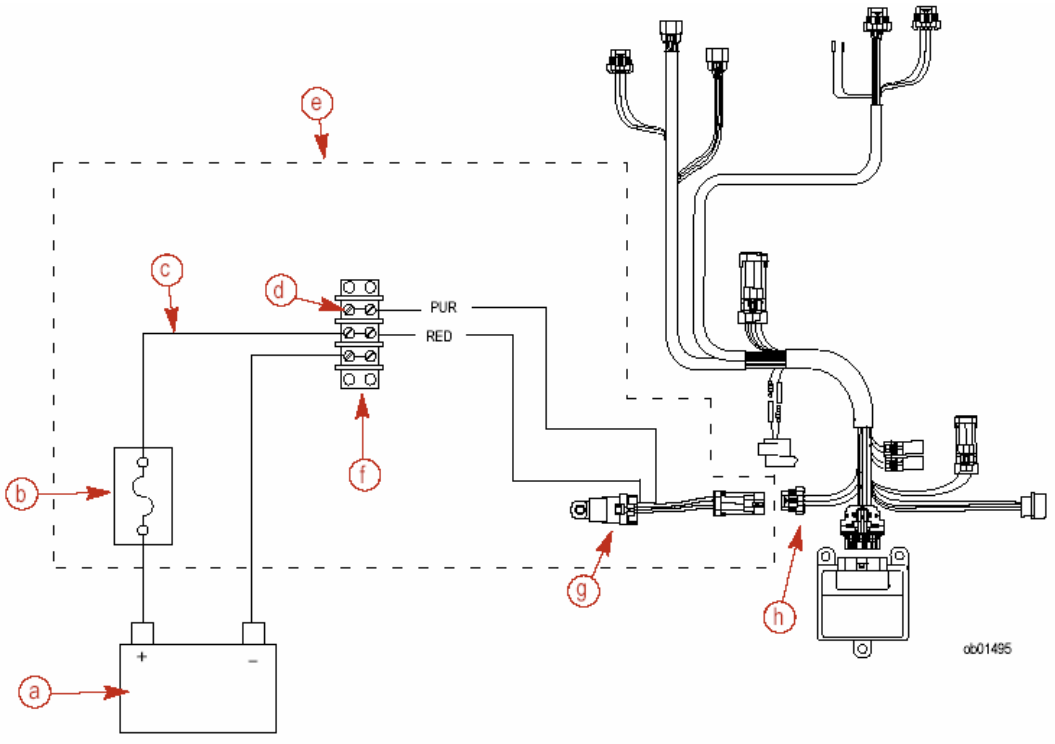
Ref.	Qty.	Description	Part Number
a	1	Boat harness assembly - fuel/paddle wheel/oil	N.S.S.
b	1	Weather cap	830796A04
c	2	Cable assembly, ring terminal	84-11149A3
d	2	Cable assembly, right angle terminal	84-875295A1
e	1	Optional 6.1 m (20 ft.) ground wire, ring terminal	84-897557A20
f	1	Optional 6.1 m (20 ft.) ground wire, right angle terminal	84-897558A20

IMPORTANT: Most vessels have Coast Guard and/or static grounds on their fuel tank. Do not add additional grounds. This is to prevent ground loop problems (power feeding back on sensor grounds) which can cause high idle and potential faults. See bulletin 2000-13.

Switched 12V Accessory Connection



a - Battery
b - Fuse - 40 Amp
c - Power harness with 40 Amp fuse
d - Switched 12V
e - Complete kit
f - Terminal block
g - Accessory power relay
h - DTS Command Module harness

Important: Needed to provide accessory power to auxiliary loads when the keyswitch is in the "Run" or "Accessory" positions.

System Wiring Installation Checklist

Data Cable

- Verify the data harness is not routed near sharp edges, hot surfaces or moving parts.
- Verify data harness is not routed near ignition components (coils, spark plug leads, and spark plugs), high power VHF coax or radios.

Junction Box (if equipped)

- Verify the data harness is not routed near sharp edges, hot surfaces or moving parts.
- Ensure the harness connections are fastened within 25.4 cm (10 in.) of the junction box.
- Verify that all unused receptacles are covered with a weather cap.

Non-Mercury Marine Supplied Ignition Key Switch

- If a non-Mercury Marine ignition key is used, verify that it passes the ingress protection testing per IEC IP66 specification minimum. Ignition switches must pass this specification.

Electronic Remote Control

- Ensure Electronic Remote Control (ERC) connections are completed following ERC installation instructions prior to engine operation.

DTS Command Module Harness

- Verify that all connectors are properly inserted and locked in their receptacle (remote control, key switch, command module, lanyard stop switch and junction box, if equipped). Verify that while moving the remote control handle (full forward and full reverse) the harness has unobstructed movement (moves freely).
- Verify that the lanyard stop switch is wired into the system correctly.
- Verify that the harness is fastened along the routing path.
- Verify that all unused connectors have weather caps to prevent corrosion.

Battery

- Verify that wing nuts have been replaced with hex nuts, provided.
- Verify that all engine battery cables are connected to the correct terminals.
- Verify that the DTS power harness leads are connected to the starting battery and secured with locknuts.
- Ensure the 5 Amp fuse for the DTS power harness is accessible.

Lanyard Stop Switch

- Verify that the switch is installed.
- Verify that the switch is connected to the DTS command module harness.

Notes

Notes

Remote Control Cables

Remote control cables are the mechanical connection between the control box and engine, selection and use of the high quality cables are imperative in maintaining this connection. Control cables are designed with a hard composite outer shell (casing) and with a solid inner core (wire). This core moves back and forth inside the casing each time the control is operated. A tighter tolerance between the core and casing, results in less lost motion (sideways travel) over the length of the cable. **The greater the length of the cable, the greater the lost motion. For longer cable runs where "lost motion" is a problem, try using the MMP 877774A__ (denotes length) Platinum throttle and shift cables.**

Measuring Throttle and Shift Cables

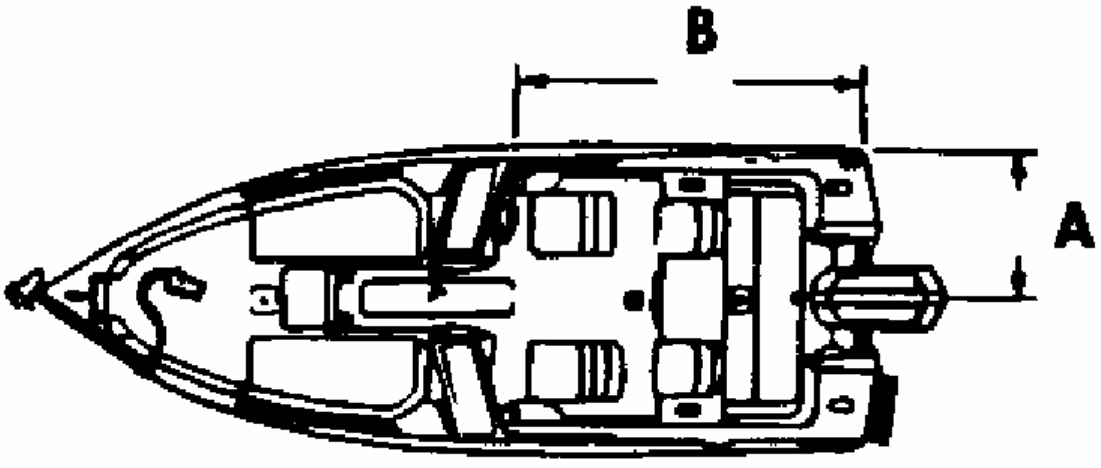
Panel Mount Remote Control

1. Add boat measurements A-B in inches (mm) and add 18 in. (457 mm) to the total. Dimension B represents the distance from the remote control location measured along the gunwale to the transom. In dual engine installations, dimension A is measured from the gunwale to each engine center-line.

2. Divide by 12 in. (304 mm).

3. This is the length of the throttle and shift cables in feet.

4. For left hand (Port) remote control installations follow the same measuring procedure, only on the opposite side of the boat.



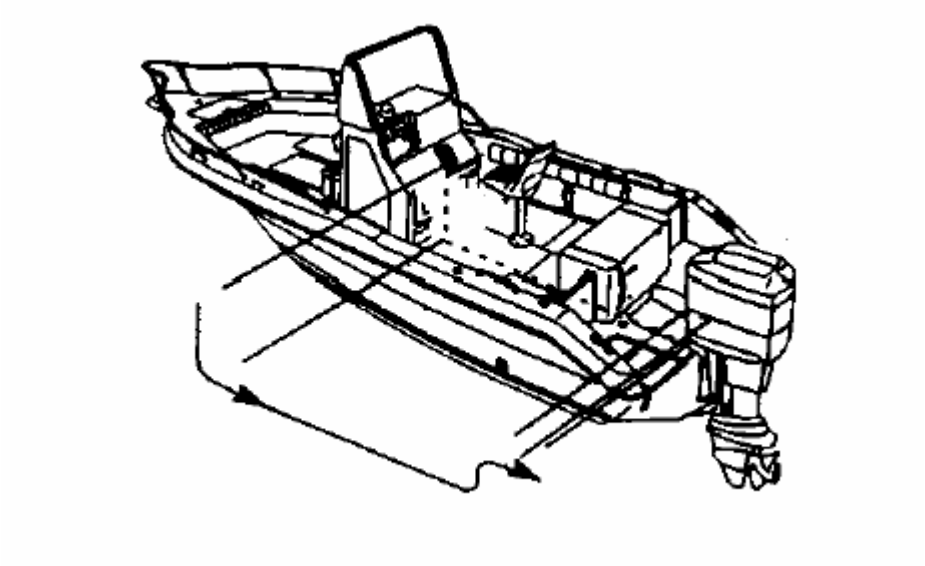
Console Mount Remote Controls

1. When measuring cable length for a console mount remote control, measure along theactual selected cable routing path and add 18 inches (457 mm) to the total.

2. Divide by 12 in. (304 mm).

3. This is the length of the throttle and shift cables in feet.

NOTE: Allow for clearance of cables directly behind panel mount remote control and under console mount remote control. The Commander 3000 Series Panel Mount Remote Control mounting surface must not exceed 1 in. (25.4 mm) thickness. Cable radius at any point must not be less than 12 in. (304.8 mm). On boats with considerable freeboard drop or unusual routing of cables, it may be necessary to add extra length to cables.



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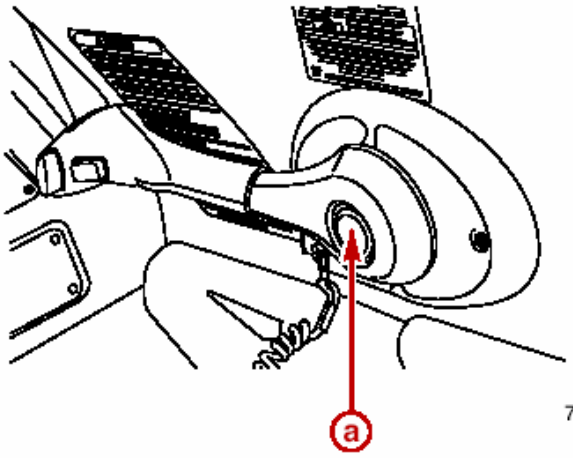
SHIFT EFFORT TOOL

Part Numbers (current at time of print)

- MPC 4000 Gen II 91-892535A01
- MCC 4500 Gen II, 91-892539A01
- MSC Commander 4000 Side Mount Tool OB, 91-892542A01
- MPC 4000 Gen II Panel Mount Tool with lock bar 91-892547A01

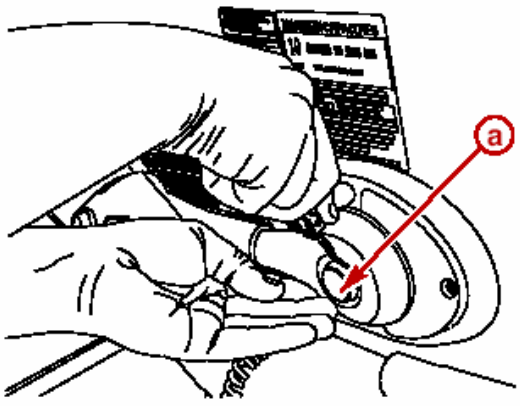
Tool Installation

1. With the engine off, push the throttle button and move the remote control into the FORWARD (F) gear position.



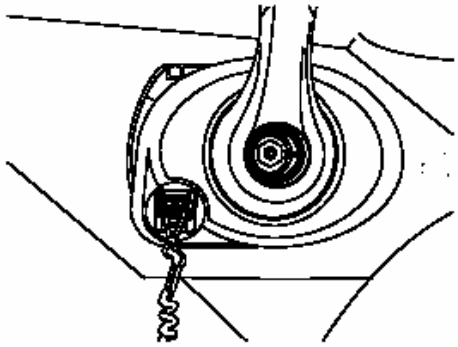
a - Throttle only button

2. Remove the throttle only button covering the hex nut in the base of the remote control using a screwdriver or similar tool.



a - Throttle only button

3. Move the remote control into the NEUTRAL (N) position.



4. Install the appropriate shift tool on the hex nut at the base of the remote control.

a. If the neutral lock button is on the bottom of the handle, push the neutral lock button in and install the clevis pin.

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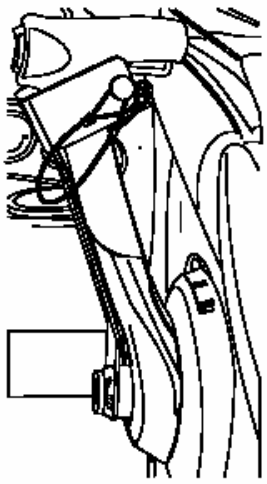

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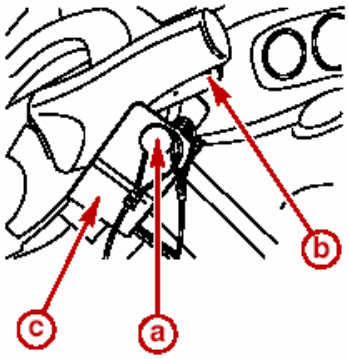
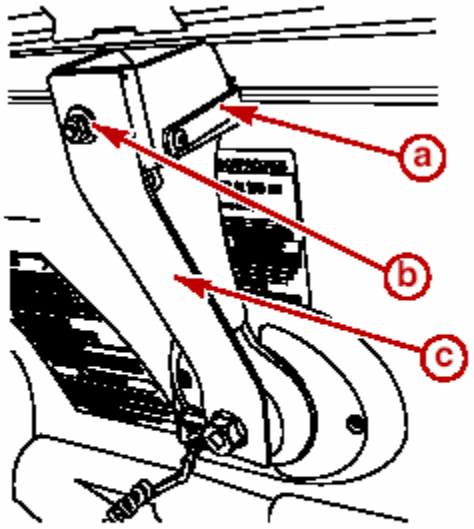


79442

a - Clevis pin
b - Neutral lock button
c - Shift Effort Tool

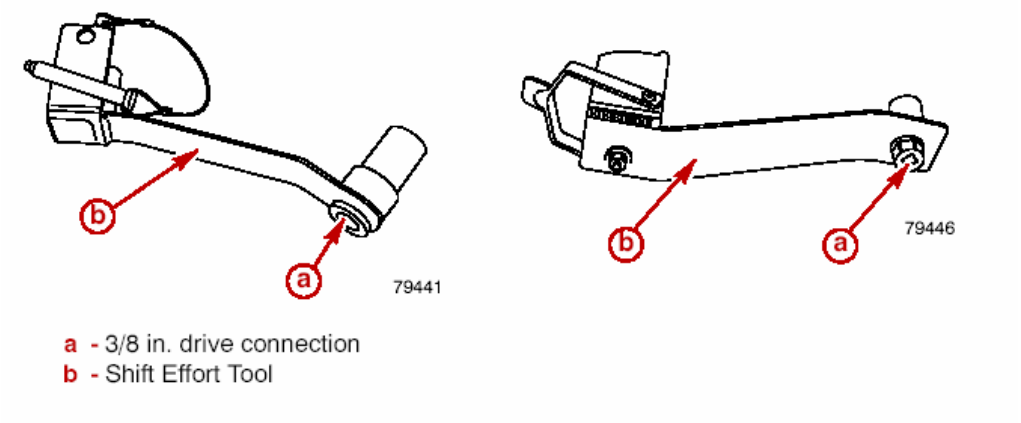
b. If the neutral lock button is on the side of the handle, firmly push the clip down. You may feel some resistance as the button is pushed in.



79448

a - Clip
b - Neutral lock button (not shown)
c - Shift Effort Tool

5. Install an inch pound torque wrench at the 3/8 in. drive connection on the back of the Shift Effort Tool.



a - 3/8 in. drive connection
b - Shift Effort Tool

Torque Specifications

Engine Not Running

CABLES NOT CONNECTED (OUTBOARD MODELS)

NOTE: The torque specifications do not reflect the force required to move the handle through the detent.

1. Measure the torque by moving the remote control handle to the detent. If the torque is not within specifications, inspect the cable routing and ensure that it is not binding.

Description	Nm	lb-in.	lb-ft
Outboard models with cables 7.62 m (25 ft) and shorter	2.3	20	
Outboard models with cables longer than 7.62 m (25 ft)	2.8	25	

Priming the Fuel and Oil System

NOTE: For initial start of a new engine or for an engine that ran out of fuel, or was drained of fuel, essentially any time maintenance to the system is required:

1. Squeeze the fuel line primer bulb until it feels firm.

2. Turn the ignition key switch to the **"ON"** position for three seconds. This operates the electric fuel pump.

3. Turn the ignition key switch back to the OFF position, and squeeze the primer bulb again until it feels firm. Turn the ignition key switch to the **"ON"** position again for three seconds. Continue this procedure until the fuel line primer bulb stays firm.

Notes

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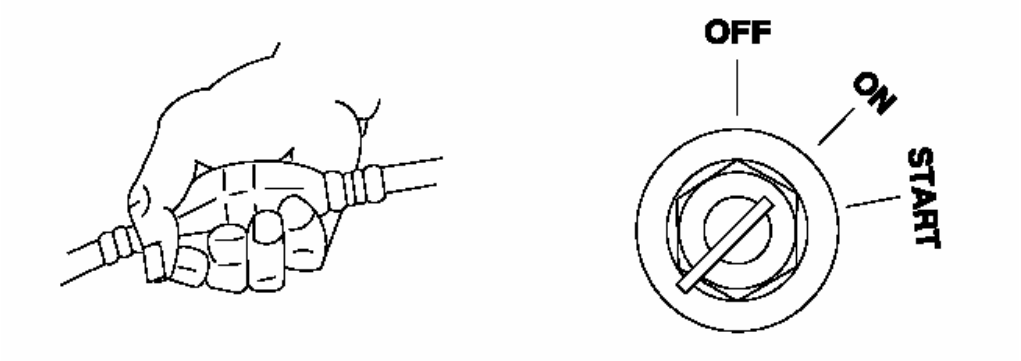


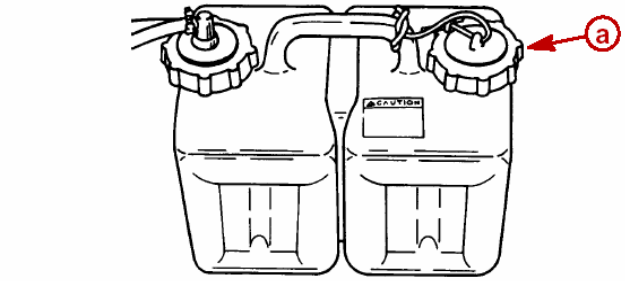
4. There are three methods for activating the priming process.

- CDS-Oil Pump Prime in ACTIVE TEST will activate the priming process.
- DDT-Oil Pump Prime in SPECIAL FUNCTIONS will activate the priming process.
- Within the first 10 seconds after the key switch has been turned on, move the remote control handle from neutral into forward gear 3 to 5 times. This will automatically start the priming process.

NOTE: It may take a few minutes for the pump to complete the priming process.

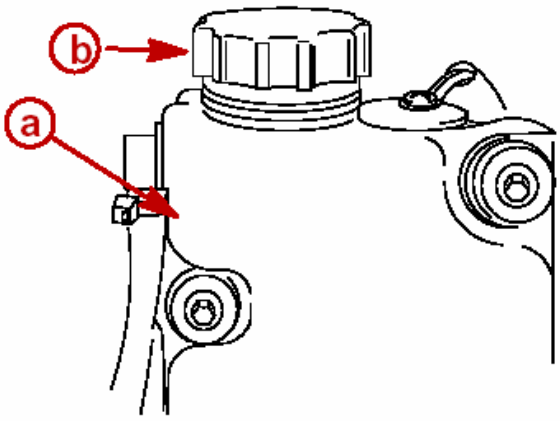
Oil Injection Set-Up

1. Fill remote oil tank with the recommended oil listed in the Operation and Maintenance Manual. Tighten fill cap.



a -Fill cap

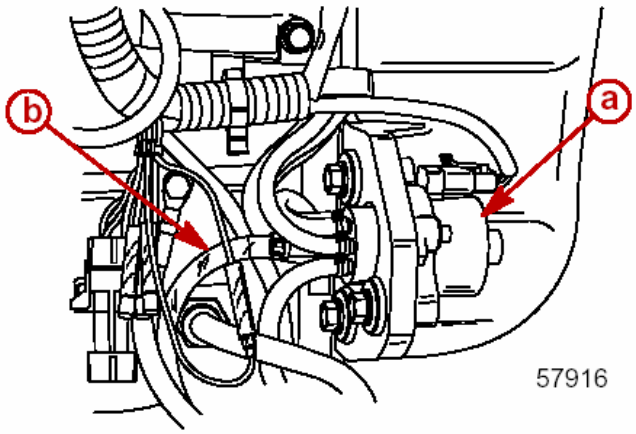
2. Remove cap and fill engine oil tank with oil. Reinstall the fill cap.



a -Engine oil tank
b -Fill cap

Priming the Oil Injection Pump

Before starting engine for the first time, prime the oil injection pump. Priming will remove any air that may be in the pump, oil supply hose, or internal passages.



a -Oil injection pump
b -Oil supply hose

⚠CAUTION

To prevent damage to the fuel pumps, fill the engine fuel system with fuel. Otherwise the fuel pumps will run without fuel during the priming process.

Notes

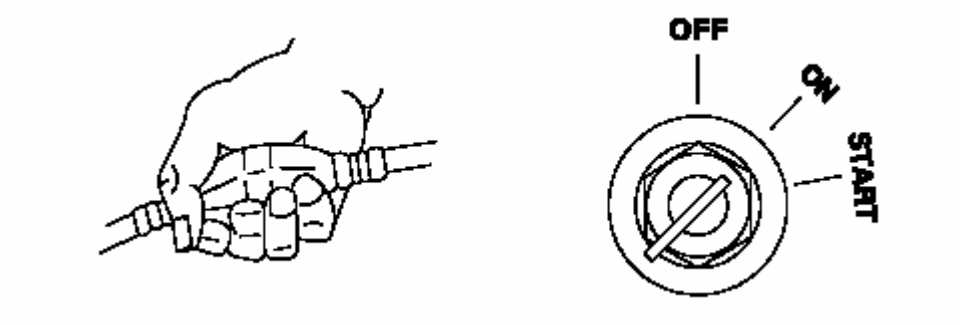
Notes

PRIMING THE OIL INJECTION PUMP

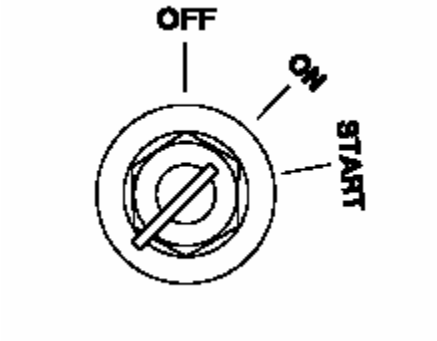
a. Connect the fuel hose. Fill the fuel system by squeezing the primer bulb. Squeeze the fuel line primer bulb until it feels firm.

b. Turn the ignition key switch to the **"ON"** position for three seconds. This operates the electric fuel pump.

c. Turn the ignition key switch back to the **"OFF"** position, and squeeze the primer bulb again until it feels firm. Turn the ignition key switch to the **"ON"** position again for three seconds. Continue this procedure until the fuel line primer bulb stays firm.



2. Turn the ignition key switch to the **"ON"** position.



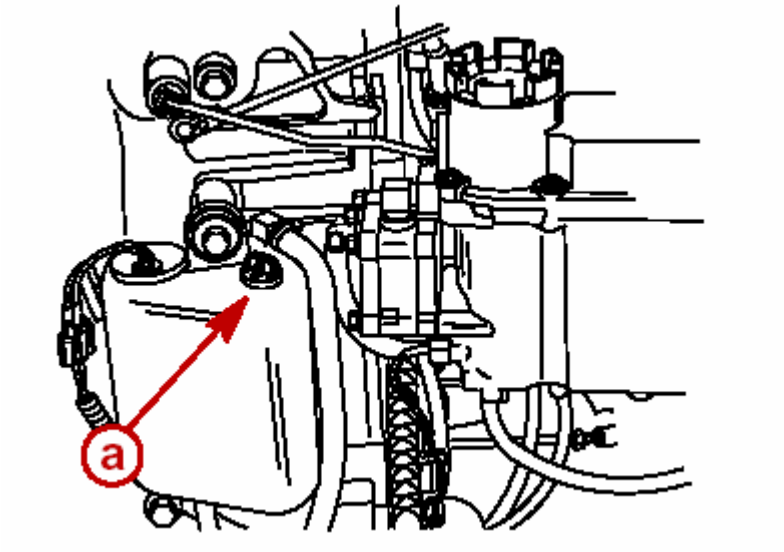
3. Within the first 10 seconds after the key switch has been turned on, move the remote control handle from neutral into forward gear 3 to 5 times. This will automatically start the priming process.

NOTE: It may take a few minutes for the pump to complete the priming process.

Purging Air From the Engine Oil Tank

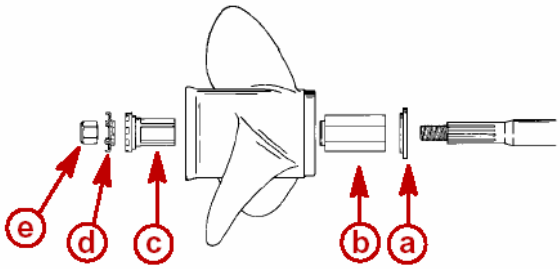
1. Loosen the fill cap on the engine oil tank.

2. Start the engine. Run the engine until the all the air has been vented out of the tank and oil starts to flow out of the tank. Re-tighten fill cap.



a- Fill Cap

Propeller Installation

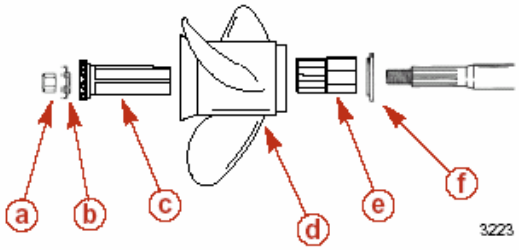


FLO-TORQ II DRIVE HUB PROPELLER

a -Forward thrust hub
b -Replaceable drive sleeve
c -Rear thrust hub
d -Propeller nut retainer
e -Propeller nut

Flow Torque III (included on 1.5L OptiMax)

NOTE: With prop shaft held stationary, the prop will have approximately 0.7620 mm (0.030) in. to 3.1750 mm (0.125) in. end play and will rotate approximately ± 10°.



a - Prop nut
b - Tab washer
c - Flo-Torq III inner brass hub/adapter
d - Propeller
e - Flo-Torq III plastic drive sleeve
f - Forward thrust washer

Notes

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The Flo-Torq III plastic drive sleeve assembly has a small forward/aft clearance so that it or the prop is not locked to the prop shaft. This allows the two hub pieces to rotate ± 10° relative to each other, and allows the springs to absorb the impacts from the combustion cycles instead of the clutch dogs. The plastic drive sleeve assembly has clearance, which allows it to move forward and aft slightly over the inner brass hub that is supplied with the Flo-Torq III hub kit. This free movement, along with the spring wires between the forward and aft section of the plastic hub, act as a shock absorber, reducing the noise. Do not shorten the inner brass hub of a Flo-Torq III prop hub; the prop must be allowed to have a slight forward and aft clearance. Aluminum props do not have the weight and mass (inertia) to remain at a constant speed. Generally aluminum props tend to remain at crankshaft speed. Because of this, the clutch dogs do not separate and there is very little or no prop rattle.

Notes

Emissions Information

Models Affected

MERCURY/MARINER/FORCE/SPORT JET

1998 and Later 2.5 thru 250 HP

MANUFACTURERS RESPONSIBILITY:

Beginning with 1998 model year engines, manufacturer's of all marine propulsion engines, must determine the exhaust emission levels for each engine horsepower family, and certify these engines with the United States Environmental Protection Agency (EPA). A certification decal/emissions control information label, showing emission levels and engine specifications directly related to emissions, must be placed on each engine at the time of manufacture.

DEALER RESPONSIBILITY:

When performing service on all 1998 and later outboards, attention must be given to any adjustments that are made, that affect emission levels. Adjustments must be kept within published factory specifications. Replacement or repair of any emission related component, must be executed in a manner that maintains emission levels within the prescribed certification standards. Dealers are not to modify an engine, in any manner, that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications. Exceptions include manufacturers prescribed changes, such as that for altitude adjustments.

OWNER RESPONSIBILITY:

The owner / operator is required to have engine maintenance performed to maintain emission levels within prescribed certification standards.

The owner / operator is not to modify the engine, in any manner, that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications.

Single engine exceptions may be allowed with permission from the EPA for racing and testing.

EPA EMISSION REGULATIONS:

All new 1998 and later outboards manufactured by Mercury Marine, are certified to the United States Environmental Protection Agency, as conforming to the requirements of the regulations for the control of air pollution from new outboard motors. This certification is contingent on certain adjustments being set to factory standards. For this reason, the factory procedure for servicing the product must be strictly followed and, wherever practicable, returned to the original intent of the design.

The responsibilities listed above are general, and are in no way a complete listing of the rules and regulations pertaining to the EPA laws on exhaust emissions for marine products. For more detailed information on this subject, you may contact the EPA at the following locations:

VIA U.S. POSTAL SERVICE:

Office of Mobile Sources

Engine Programs and Compliance Division

Engine Compliance Programs Group (6403J)

401 M St. NW

Washington, DC 20460

VIA EXPRESS or COURIER MAIL:

Office of Mobile Sources

Engine Programs and Compliance Division

Engine Compliance Programs Group (6403J)

501 3rd St. NW

Washington, DC 20001

EPA INTERNET WEB SITE:

http:/www.epa.gov/omswww

Exhaust Emissions Standards

Through the Environmental Protection Agency (EPA), the federal government has established exhaust emissions standards for all new marine engines sold in the U.S.

What Are Emissions?

Emissions are what comes out of the exhaust system in the exhaust gas when the engine is running. They are formed as a result of the process of combustion or incomplete combustion. To understand exhaust gas emissions, remember that both air and fuel are made of several elements. Air contains oxygen and nitrogen among other elements; gasolene contains mainly hydrogen and carbon. These four elements combine chemically during combustion. If combustion were complete, the mixture of air and gasoline would result in these emissions: water, carbon dioxide and nitrogen, which are not harmful to the environment. But combustion is not usually complete. Also, potentially harmful gases can be formed during and after combustion.

All marine engines must reduce the emission of certain pollutants, or potentially harmful gases, in the exhaust to conform with levels legislated by the EPA. Emissions standards become more stringent each year. Standards are set primarily with regard to three emissions: hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx).

Notes

Notes

Hydrocarbons – HC

Gasoline is a hydrocarbon fuel. The two elements of hydrogen and carbon are burned during combustion in combination with oxygen. But they are not totally consumed. Some pass through the combustion chamber and exit the exhaust system as unburned gases known as hydrocarbons.

Carbon Monoxide – CO

Carbon is one of the elements that make up the fuel burned in the engine along with oxygen during the combustion process. If the carbon in the gasoline could combine with enough oxygen (one carbon atom with two oxygen atoms), it would come out of the engine in the form of carbon dioxide (CO2). CO2 is a harmless gas. But carbon often combines with insufficient oxygen (one carbon atom with one oxygen atom). This forms carbon monoxide, CO. Carbon monoxide is the product of incomplete combustion and is a dangerous, potentially lethal gas.

Oxides of Nitrogen - NOx

NOx is a slightly different byproduct of combustion. Nitrogen is one of the elements that makes up the air going into the engine. Under extremely high temperatures it combines with oxygen to form oxides of nitrogen (NOx). This happens in the engine's combustion chambers when temperatures are too high. Nox itself is not harmful, but when exposed to sunlight it combines with unburned hydrocarbons to create the visible air pollutant known as smog. Smog is a serious problem in California as well as many other heavily populated areas of the United States.

Controlling Emissions

There are two principle methods of reducing emissions from a two-stroke-cycle marine engine. The first method is to control the air/fuel ratio that goes into the combustion chamber. The second is to control the time when this air/fuel mixture enters the combustion chamber. Timing is important, to prevent any unburned mixture from escaping out of the exhaust port.

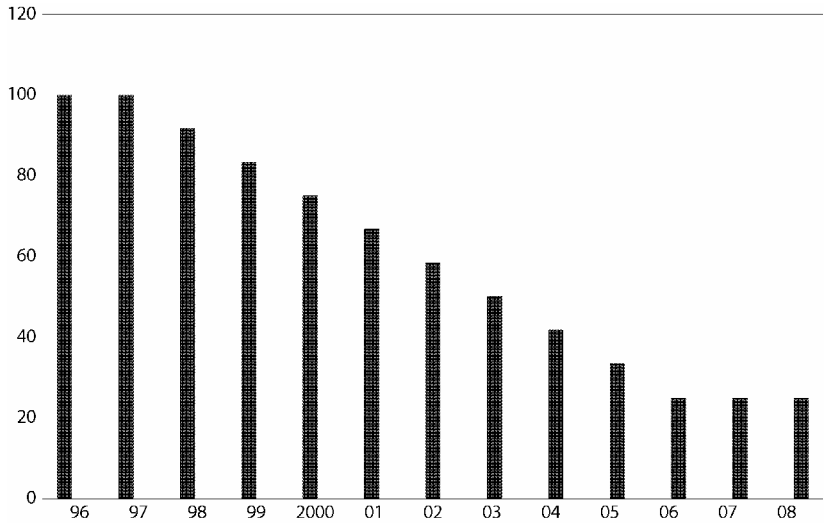
Stoichiometric (14.7:1) Air/Fuel Ratio

In the search to control pollutants and reduce exhaust emissions, engineers have discovered that they can be reduced effectively if a gasoline engine operates at an air/fuel ratio of 14.7:1. the technical term for this ideal ratio is stoichiometric. An air/fuel ratio of 14.7:1 provides the best control of all three elements in the exhaust under almost all conditions. The HC and CO content of the exhaust gas is influenced significantly by the air/fuel ratio. At an air/ fuel ratio leaner than 14.7:1, HC and CO levels are low, but with a ratio richer than 14.7:1 they rise rapidly. It would seem that controlling HC and CO by themselves might not be such a difficult task; the air/fuel ratio only needs to be kept leaner than 14.7:1. However, there is also NOx to consider.

As the air/fuel ratio becomes leaner, combustion temperatures increase. Higher combustion temperatures raise the NOx content of the exhaust. But, enrichening the air/fuel ratio to decrease combustion temperatures and reduce NOx also increases HC and CO, as well as lowering fuel economy. So the solution to controlling Nox - as well as HC and CO - is to keep the air/fuel ratio as close to 14.7:1 as possible.

Outboard Hydrocarbon Emissions Reductions

8 1/3% _ PER YEAR OVER 9 MODEL YEARS



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Engine Emission Certification Label

Your outboard has been labeled on the cowl with one of the following star labels.

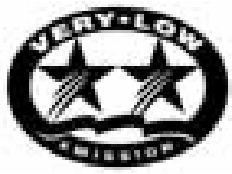
The Star Label means Cleaner Marine Engines.

The Symbol for Cleaner Marine Engines Means:

Cleaner Air and Water – for a healthier lifestyle and environment.

Better Fuel Economy – burns up to 30-40 percent less gas and oil than conventional carbureted two-stroke engines, saving money and resources.

Longer Emission Warranty – Protects consumer for worry free operation.

	The one-star label identifies engines that meet the CARB's 2001 exhaust emission standards. Engines meeting these standards have 75% lower emissions than conventional carbureted 2-stroke engines. These engines are equivalent to the U.S. EPA's 2006 standards
	The two-star label identifies engines that meet the CARB's 2004 exhaust emission standards. Engines meeting these standards have 20% lower emissions than One Star - Low Emission engines.
	The three-star label identifies engines that meet the CARB's 2008 exhaust emission standards. Engines meeting these standards have 65% lower emissions than One Star - Low Emission engines.

Notes

Notes

Speed / Density Theory and Operation

Speed/Density Theory

Outboard OptiMax engines operate on the fuel injection strategy called “Speed/Density”. This means that the ECM primarily looks at the engine’s **speed** and the intake manifold’s air **density** in order to calculate the correct amount of fuel to inject.

The engine requires an air/fuel mixture of approximately 14:7 to 1 in the combustion chambers.

Since the system doesn’t control air flow, it must determine how much air is flowing through the engine in order to calculate the correct amount of time to fire the fuel injectors. The net result is that there must be 1 part of fuel for every 14.7 parts of air going through the engine.

Since the engine is basically an air pump, we know that an engine is capable of pumping a certain (maximum) amount of air at any specific rpm. The actual amount of air it pumps (at a specific rpm) depends on the density of the air in the intake manifold. The air density (in the intake manifold) will vary depending on rpm, throttle plate position and barometric pressure.

If the air density in the intake manifold is known, the actual amount of air flowing through the engine (the “Air Mass” or “Mass Air Flow”) **could** be calculated. This calculated (and the actual) air flow is a repeatable function, meaning that at a specific rpm and a specific manifold absolute pressure reading, the air flow through the engine will always be the same.

However, in the speed/density system we do not actually calculate the actual air flow. Instead, the ECM measures the rpm and the air density, then refers to a programmed “lookup table” in the ECM’s EEPROM. This lookup table will be programmed with the correct fuel injector information for every rpm and density reading. The programming engineer has to come up with these figures, because the ECM is not actually calculating the Mass Air Flow.

The speed-density system depends on the engine being unmodified (from its original production state). If we change the volumetric efficiency of the engine in any manner, the amount of air flow for a given rpm and air density will change, causing the ECM to deliver the incorrect amount of fuel. Any modification to the following components will influence the air flow through the engine, throwing the speed-density system out of calibration.

a) Pistons and combustion chambers (anything that changes the compression ratio).
b) Changes to intake and exhaust port size, as well as “porting and polishing”.

Speed/Density Operation

To determine the density of the air in the intake manifold, we need to know the intake manifold vacuum, which we measure with the MAP (Manifold Absolute Pressure) sensor. It is important to remember that a MAP sensor measures the manifold pressure **above** absolute zero (like a barometer), while a conventional vacuum gauge measures the manifold pressure **below** the **current** atmospheric pressure. The use of the Manifold Absolute Pressure Sensor allows us to compensate for variations in atmospheric pressure due to weather and altitude changes. A conventional vacuum gauge would not provide us with this needed information.

NOTE: *While the temperature of the air does affect its density, not all engines use an IAT (intake air temperature) sensor. If no IAT is present, then the ECM assumes 75 degree Fahrenheit for all density calculations. If an IAT is present, then the ECM can more accurately determine the air's density. However, the amount of correction the IAT adds is a relatively small amount (approximately 10% maximum change in fuel flow).*

In review, our standard, unmodified production engines flow a repeatable (and therefore "known") amount of air at any specific engine rpm and manifold pressure. With this knowledge, the ECM can be programmed to deliver the correct amount of fuel from the combination of the speed sensor (distributor signal) and density information (from the MAP sensor).

It is often said that the speed-density system runs "in theory alone", since the ECM doesn't really know how much air is flowing through the engine, it is just assuming it knows how much (based on the repeatability of airflow theory). In reality, the system is simple, rugged and works extremely well. But, the ECM cannot compensate for changes in volumetric efficiency of the engine.

Mass Air Flow Systems

Mass Air Flow systems actually measure the amount of air (or "Air Mass") entering the engine, so they generally can compensate for modifications or changes to the air flow through the engine. While these systems are generally considered more accurate, they are generally not as robust (and cost effective) as the speed-density system. Mass Air Flow systems are typically used in automotive applications to meet stringent emissions and fuel economy requirements.

NOTE: The speed-density system is more than accurate enough for our marine applications. The additional reduction in emissions and the resulting increase in fuel economy (with the Mass Air Flow system) are negligible. But when automotive manufacturers must meet emissions standards, they often have to take small improvements where they can find them.

Notes

Notes

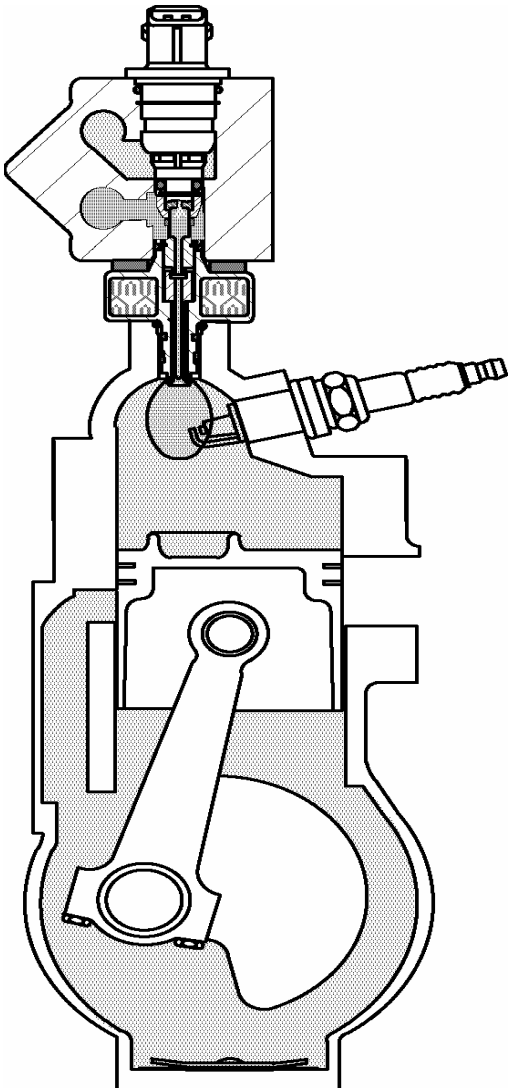
Stratified VS Homogenized Charge

OptiMax engines use a stratified charge inside the combustion chamber to aid in reducing emissions. All other models use a homogenized charge. The difference between the two is:

Stratified Charge

A stratified charge engine only pulls air through the transfer system. The fuel required for combustion is forced into the cylinder through an injector placed in the top of the cylinder head. The injector sprays a fuel/air mixture in the form of a bubble into the cylinder. Surrounding this bubble is air supplied by the transfer system. As the bubble is ignited and burns, the surrounding air provides almost complete combustion before the exhaust port opens.

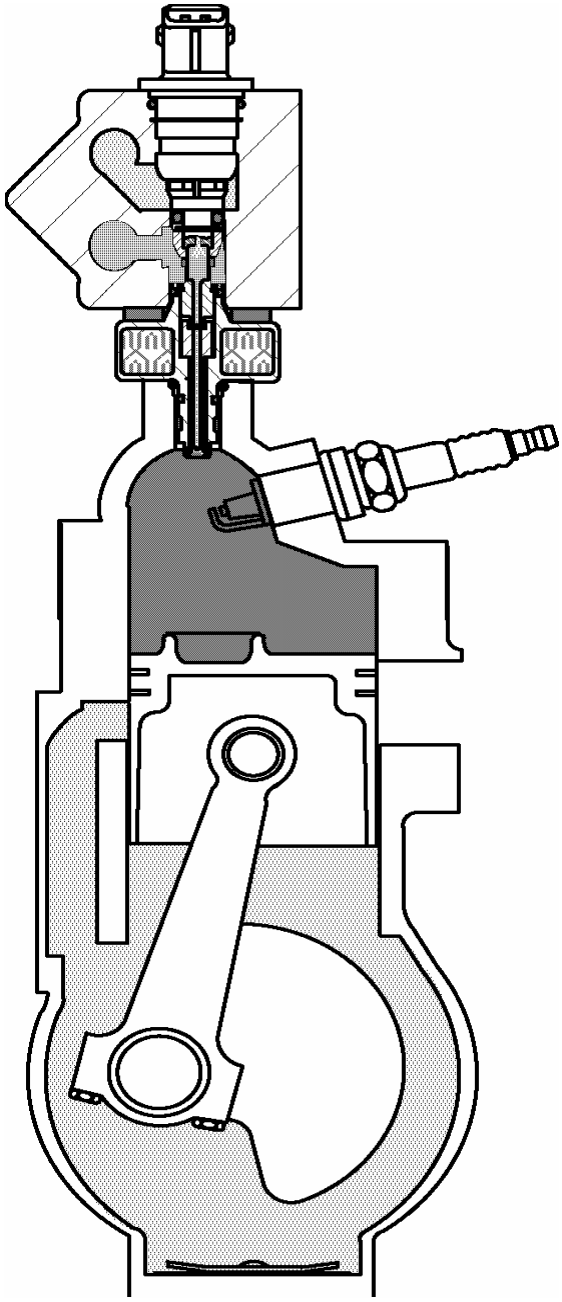
A stratified charge is hard to ignite, the fuel/air bubble is not evenly mixed at 14.7:1 and not easily ignited.



Homogenized Charge

A homogenized charge has the fuel/air particles mixed evenly throughout the cylinder. This mixing occurs inside the carburetor venturi, reed blocks and crankcase. Additional mixing occurs as the fuel is forced through the transfer system into the cylinder.

The homogenized charge is easy to ignite as the air/fuel ratio is approximately 14.7:1.



Notes

Notes

Theory of Operation - V6 Models

Air Induction Through Crankcase

Combustion air enters the cowl through holes located in the top aft end of the cowl. The cowl liner directs this air to the bottom of the powerhead. This limits the exposure of salt air to the components inside the engine cowl.

Once inside the cowl the air enters the plenum through the throttle shutter(s) which are located in the plenum assembly The air then continues through the reed valves and into the crankcase The throttle shutter(s) are actuated by the throttle shaft. Mounted onto a separate shaft are two throttle position sensors (TPS) These sensors tell the engine control unit (ECM) the position of the throttle.

1997/1998/1999 MODELS

Two TPS's are installed on the OptiMax engine for safety redundancy. If one TPS should fail, the dash mounted CHECK ENGINE light will flash and the warning horn will sound. The 1997 Model engine will continue to perform normally; the 1998/99 models engine speed will be reduced to 3000 RPM. If both TPS's should fail, engine speed will be reduced to idle.

To reduce emissions, OptiMax engines require large amounts of air into the cylinders at idle speed. To accomplish this, the throttle shutters are partially open at low engine speeds. The dual TPS system reads the shaft movement in both directions, one reads movement up (increasing resistance), while the other reads the same movement as down (decreasing resistance). The ECM reads both and calculates the throttle shutter position.

2000 MODELS & NEWER

One TPS is used on these models, if the TPS fails, the ECM will default to the MAP sensor. If both the TPS and MAP sensors fail, the engine is limited to idle speed.

Air Compressor System

Air from inside the engine cowl is drawn into the compressor through the flywheel cover or air plenum. This cover acts like a muffler to quiet compressor noise and contains a filter to prevent the ingestion of debris into the compressor.

A restrictor is located between the filter and compressor. The restrictor design lowers the compressor intake noise and should be removed at altitudes above 5000 feet (1997 models)

The compressor is driven by a serpentine belt from a pulley mounted on the crankshaft, and is automatically self adjusted using a single idler pulley. This air compressor is a single cylinder unit containing a connecting rod, piston, rings, bearings, reed valves, and a crankshaft. The compressor is water cooled to lower the temperature of the air charge and is lubricated by oil from the engine oil pump assembly.

As the compressor piston moves downward inside the cylinder, air is pulled through the filter, reed valves and into the cylinder. After the compressor piston changes direction, the intake reeds close and the exhaust reeds open allowing compressed air into the hose leading to the air/fuel rails. An orifice is installed in the line between the compressor and air rail to smooth the pulses transmitted from the compressor to the air rail.

The air/fuel rails contain two passages; one for fuel, the second is the air passage. The air passage is common between all the cylinders included in the rail. A hose connects the starboard rail air passage to the air compressor. Another hose connects the starboard air rail passage to the port air rail passage.

An air pressure regulator limits the amount of pressure developed inside the air passages to approximately 80 psi. Air exiting the pressure regulator is returned into the exhaust adaptor (intake plenum 2000 3.0L) and exits thru the propeller.

Notes

Notes

Fuel

Fuel for the engine is stored in a fuel tank. A primer bulb is installed into the fuel line to allow priming of the fuel system. A crankcase mounted pulse driven diaphragm fuel pump (electric on V-6 M2 Jet Models) draws fuel through the fuel line, primer bulb, fuel pump assembly and then pushes the fuel thru a water separating fuel filter. This filter removes any contaminates and water before the fuel reaches the vapor separator.

Fuel vapors are bled into the air compressor inlet in the front of the flywheel cover preventing a vapor lock of the electric fuel pump assembly which is mounted in the vapor separator. The low pressure electric fuel pump was added in 1998 to eliminate potential vapor locking of the fuel system. This pump draws fuel from the main chamber of the vapor separator tank (VST) and pushes the fuel into the chamber where the high pressure electric fuel pump is located. This creates a pressure of approximately 6 to 7 psi on the intake side of the high pressure fuel pump.

Excess fuel in the high pressure chamber returns to the main VST chamber through a 0.030” hole. The high pressure electric fuel pump is different than the fuel pump that is utilized on the standard EFI engine (non OptiMax), and is capable of developing fuel pressures in excess of 90 psi. Fuel inside the rail must remain pressurized at exactly 10 psi over the air rail pressure or the ECM (map) calibrations will be incorrect. Fuel from the vapor separator is supplied to the top of one fuel rail. A fuel line connects the bottom of the first rail to the opposite fuel rail. Fuel is stored inside the rail until an injector opens. A fuel pressure regulator controls pressure in the fuel rails, and allows excess fuel to return into the vapor separator. The fuel regulator not only regulates fuel pressure but also regulates it at approximately 10 p.s.i. higher than whatever the air rail pressure is. The fuel regulator diaphragm is held closed with a spring that requires 10 p.s.i. to force the diaphragm off the diaphragm seat. The back side of the diaphragm is exposed to air rail pressure. As the air rail pressure increases, the fuel pressure needed to open the regulator will equally increase. Example: If there is 50 p.s.i. of air pressure on the air rail side of the diaphragm, 60 p.s.i. of fuel pressure will be required to open the regulator. The return fuel line to the vapor separator is water cooled. This design is used to prevent cold fuel from the fuel tank hitting the hot fuel returning from the fuel rail and flashing off the light ends (boiling over).

To equalize the pulses developed by the pumps (both air and fuel) a tracker diaphragm is installed in the starboard rail. The tracker diaphragm is positioned between the fuel and air passages. The tracker diaphragm is a rubber diaphragm which expands and retracts depending upon which side of the diaphragm senses the pressure increase (pulse).

Oil

Oil in this engine is not mixed with the fuel before entering the combustion chamber. Oil is stored inside a standard remote oil reservoir. Crankcase pressure will force oil from the remote oil reservoir into the oil storage tank on the side of the powerhead. Oil will flow from the oil storage tank into the oil pump. The oil pump is a solenoid design. It is activated by the ECM and includes pistons with corresponding discharge ports. The oil pump is mounted directly onto the powerhead. Each cylinder is lubricated by one of the discharge ports. The oil is discharged into the crankcase in front of the reed blocks or crankcase cover. The seventh passage connects to the hose that leads to the air compressor for lubrication. Excess oil from the compressor returns into the plenum and is ingested through the crankcase. Later models have check valves inside the cylinder oil circuits. These check valves prevent evacuation of the oil hoses under certain operating conditions.

The ECM will change the discharge rate of the oil pump, depending upon engine demand. The ECM will also pulse the pump on initial start up to fill the oil passages eliminating the need to bleed the oil system. The ECM provides additional oil for break in, as determined by its internal clock. The oil ratio ranges from 300-400:1 at idle to 60:1 at WOT. A OptiMax engine will use less oil than a non-OptiMax engine.

Electrical

The electrical system consists of the ECM, crank position sensor (flywheel speed & crankshaft position), throttle position sensor (TPS), MAP sensor, engine temperature sensor, ignition coils, water pressure sensor (not used on all models) and injectors (fuel & direct). The engine requires a battery to start (i.e. the ignition and injection will not occur if the battery is dead). The system will run off of the alternator.

Operation

The operation of the system happens in milliseconds (ms); exact timing is critical for engine performance. As the crankshaft rotates, air is drawn into the crankcase through the throttle shutters, into the plenum, and through the reed valves. As the piston nears bottom-dead-center, air from the crankcase is forced through the transfer system into the cylinder. As the crankshaft continues to rotate the exhaust and intake ports close. With these ports closed, fuel can be injected into the cylinder. The ECM will receive a signal from the throttle position sensor (TPS), engine temperature sensor (TS) and the crank position sensor (flywheel speed and position sensor). With this information the ECM refers to the fuel calibration (maps) to determine when to activate (open and close) the injectors and fire the ignition coils. With the piston in the correct position, the ECM opens the fuel injector, approximately 90 psi fuel is discharged into a machined cavity inside the air chamber of the air/fuel rail. This mixes the fuel with the air charge. Next the direct injector will open, discharging the air/fuel mixture into the combustion chamber. The direct injector directs the mixture at the bowl located in top of the piston. The piston's bowl directs the air/fuel mixture into the center of the combustion chamber. This air fuel mixture is then ignited by the spark plug.

Notes

Notes

Compressor Notes: To aid in starting when the air rail pressure is low and before the compressor has time to build pressure, the direct injector is held open by the ECM. This allows the compression from inside the cylinders to pressurize the air rail faster (1 or 2 strokes, or 60° of crankshaft rotation).

Idle Notes: Idle quality is controlled by fuel volume and fuel timing. The throttle shutters will be open at idle speeds. The shift cut-out switch will interrupt the fuel to 3 of the cylinders to assist in shifting.

The TPS signals the ECM to change the fuel and spark without movement of the throttle shutters. The throttle cam is manufactured to allow the TPS sensor shaft to move before opening the throttle shutters.

Theory of Operation - 3 Cylinder Models

Notes

Air Induction Through Crankcase

Combustion air enters the cowl through holes located in the top aft end of the cowl. The cowl liner directs this air to the bottom of the powerhead. This limits the exposure of salt air to the components inside the engine cowl. Once inside the cowl the air enters the plenum through the throttle shutter which is located in the plenum assembly. The air then continues through the reed valves and into the crankcase. The throttle shutter is actuated by the throttle shaft. Mounted on a separate shaft is a throttle position sensor (TPS). This sensor tells the propulsion control unit (PCM) the position of the throttle.

Air Compressor System

Air from inside the engine cowl is drawn into the compressor through an air filter in the air attenuator. This attenuator acts like a muffler to quiet compressor noise and contains a filter to prevent the ingestion of debris into the compressor. The compressor is driven by a belt from a pulley mounted on the flywheel and is automatically self-adjusted using a single idler pulley. This air compressor is a single cylinder unit containing a connecting rod, piston, rings, bearings, reed valves, and a crankshaft. The compressor is water cooled to lower the temperature of the air charge and is lubricated by oil from the engine oil pump assembly. As the compressor piston moves downward inside the cylinder, air is pulled through the filter, reed valves and into the cylinder. After the compressor piston changes direction, the intake reeds close and the exhaust reeds open allowing compressed air into the hose leading to the air/fuel rails.

The air/fuel rails contain two passages; one for fuel, the second for air. The air passage is common between all the cylinders included in the rail. A hose connects the rail air passage to the air compressor. An air pressure regulator will limit the amount of pressure developed inside the air passages to approximately [i.e. 648.1 kPa (94 psi) air vs 744.6 kPa (108 psi) fuel]. Air exiting the pressure regulator is discharged through a muffler into the lower cowling.

Notes

Fuel

Fuel for the engine is stored in a typical fuel tank. A primer bulb is installed into the fuel line to allow priming of the fuel system. A vapor separator mounted diaphragm fuel pump draws fuel through the fuel line, primer bulb and fuel pump assembly. The pump then pushes the fuel through a water separating fuel filter. This filter removes any contaminates and water before the fuel reaches the vapor separator. Fuel vapors are vented through the bottom cowling into the atmosphere. The electric fuel pump is capable of developing fuel pressures in excess of 744.6 kPa (108 psi). Fuel inside the rail must remain pressurized at exactly 96.5 kPa (14 psi) over the air rail pressure or the PCM (map) calibrations will be incorrect. Fuel from the vapor separator is supplied to the top of the fuel rail. Fuel is stored inside the rail until an injector opens. A fuel pressure regulator controls pressure in the fuel rail, and allows excess fuel to return into the vapor separator. The fuel regulator not only regulates fuel pressure but also regulates it at 96.5 kPa (14 psi) higher than whatever the air rail pressure is. The fuel regulator diaphragm is held closed with a spring that requires 96.5 kPa (14 psi) to force the diaphragm off the diaphragm seat. The back side of the diaphragm is exposed to air rail pressure. As the air rail pressure increases, the fuel pressure needed to open the regulator will equally increase. Example: If there is 344.7 kPa (50 psi) of air pressure on the air rail side of the diaphragm, 441.3 kPa (64 psi) of fuel pressure will be required to open the regulator. The fuel rail is water cooled.

Oil

Oil in this engine is not mixed with the fuel before entering the combustion chamber. Oil is stored inside an engine mounted reservoir.

A remote oil tank is available as an option. Crankcase pressure will force oil from the remote oil tank into the oil reservoir on the front of the powerhead.

Oil will flow from the oil reservoir into the oil pump. The oil pump is a solenoid design. It is activated by the PCM and includes 7 pistons with corresponding discharge ports. The oil pump is mounted on the electrical plate. Each cylinder is lubricated by one of the discharge ports. The oil is discharged into the crankcase. The seventh passage connects to the hose that leads to the air compressor for lubrication. Excess oil from the compressor returns into the cylinder bores.

The PCM will change the discharge rate of the oil pump, depending upon engine demand. The PCM will also pulse the pump on initial start up to fill the oil passages eliminating the need to bleed the oil system. The PCM provides additional oil for break-in, as determined by its internal clock. The oil ratio varies with engine RPM and load.

Electrical

The electrical system consists of the PCM, crank position sensor (flywheel speed & crankshaft position), throttle position sensor (TPS), MAP sensor, engine temperature sensor, ignition coils and injectors (fuel & direct). The engine requires a battery to start (i.e. the ignition and injection will not occur if the battery is dead). The system will run off of the alternator.

Operation

The operation of the system happens in milliseconds (ms). Exact timing is critical for engine performance. As the crankshaft rotates, air is drawn into the crankcase through the throttle shutter, into the plenum and through the reed valves. As the piston nears bottom dead center, air from the crankcase is forced through the transfer system into the cylinder. As the crankshaft continues to rotate the exhaust and intake ports close. With these ports closed, fuel can be injected into the cylinder. The PCM will receive a signal from the throttle position sensor (TPS), engine temperature sensor (TS) and the crank position sensor (flywheel speed and position sensor). With this information, the PCM refers to the fuel calibration (maps) to determine when to activate (open and close) the injectors and fire the ignition coils. With the piston in the correct position, the PCM opens the fuel injector, 744.6 kPa (108 psi) fuel is discharged into a machined cavity inside the air chamber of the air/fuel rail. This mixes the fuel with the air charge. Next the direct injector will open, discharging the air/fuel mixture into the combustion chamber. The direct injector directs the mixture at the bowl located in top of the piston. The piston's bowl directs the air/fuel mixture into the center of the combustion chamber. This air fuel mixture is then ignited by the spark plug.

Compressor Notes: To aid in starting when the air rail pressure is low and before the compressor has time to build pressure, some direct injectors are held open by the PCM. This allows the compression from inside the cylinders to pressurize the air rail faster (1 or 2 strokes, or 60◦ of crankshaft rotation).

Idle Notes: Idle quality is controlled by fuel volume and fuel timing. The throttle shutter will be open at idle speed. The shift switch is mounted on the exhaust adaptor plate and is activated by a cam/notch in the upper shift shaft. The switch has a closed circuit when the engine is in gear (forward or reverse) and an open circuit when the engine is in neutral. The switch is monitored by the PCM. The PCM will change fueling, timing and RPM limit according to whether the engine is in gear or in neutral.

The TPS signals the PCM to change the fuel and spark without movement of the throttle shutters. The throttle cam is manufactured to allow the TPS sensor shaft to move before opening the throttle shutter.

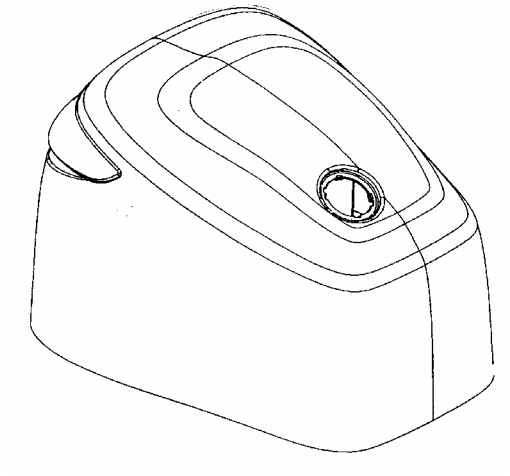
Notes

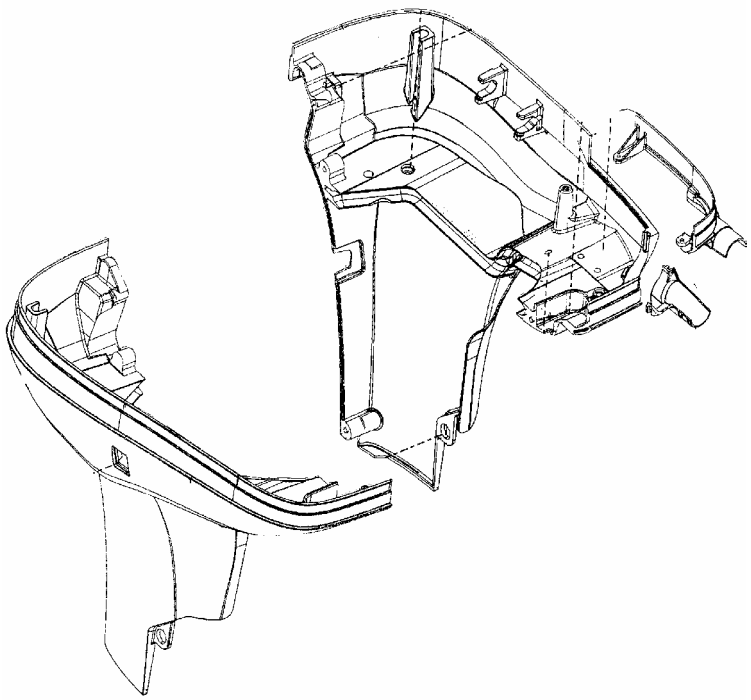
3 Cylinder/1.5 Liter

75/90/115 HP

Cowls (Upper & Lower)

- One piece light weight upper cowl.
- Two piece lower cowls that extend down the drive shaft housing. The extended lower cowls have sound blankets to reduce engine noise.
- Removable panel on lower Port cowl to allow installation of control cables.





Notes

Notes

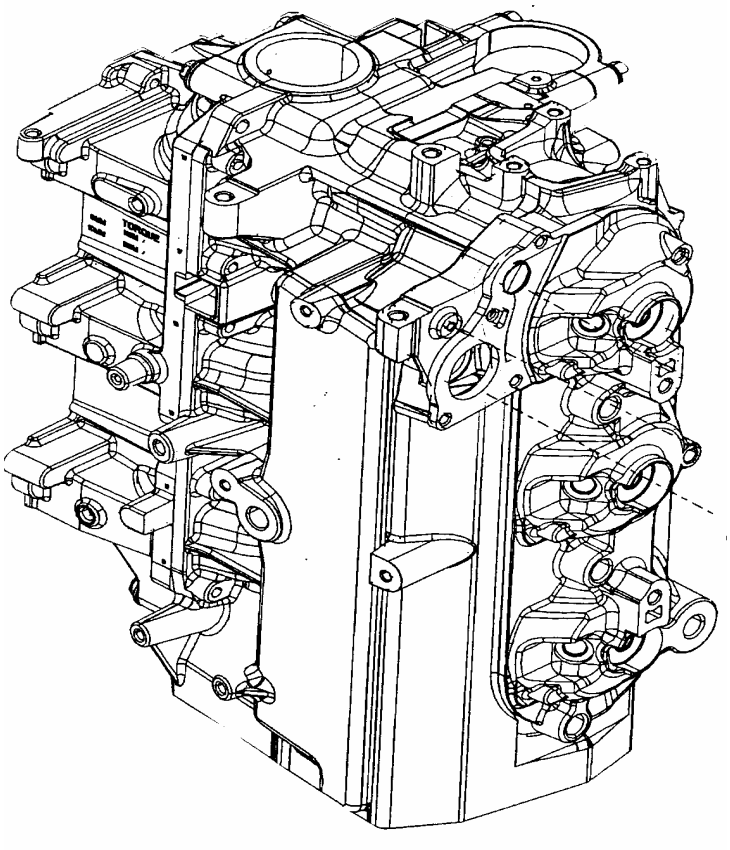
Emissions & Noise Levels

- Three star emission levels
- Operator ear sound pressure level (ICOMIA 39/94: 83.2 dBA

Powerhead

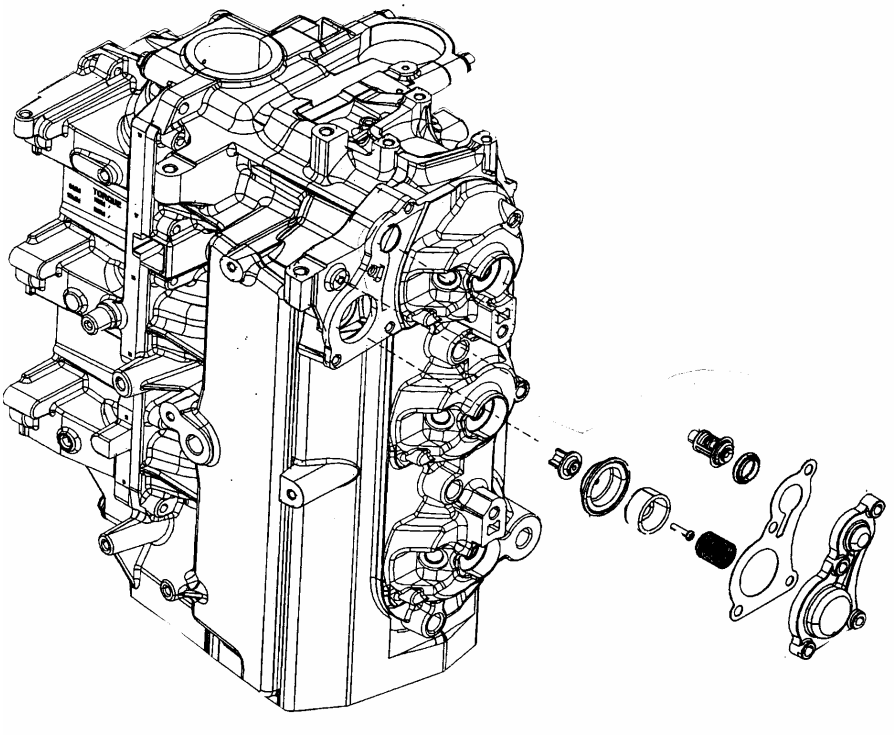
- Three Cylinder, 1.5 Liter
- Same cylinder bore (92.1131 mm (3.6265 in.) as 3.0 Liter Outboard
- Lost foam cylinder block with one piece block, head and water jacket design.
- Cast iron cylinder liners
- Power head is turned 10 ° on drive shaft housing, to improve exhaust flow, and make clearance for IVST.
- Change HP by changing cylinder liners/porting
- Bottom guided connecting rods, using the same bearing as 3.0 Liter. The 1.5 Liter rod is shorter than 3.0 Liter connecting rod.
- Piston rings are steel with chrome face.

NOTE: *The flywheel has a damper to reduce engine vibration.*



Cooling System

- Thermostat/poppet valve controlled.
- 142 degree thermostat
- Water deflectors (3) to direct water flow around cylinders.
- Same water pump as currently used on 75 – 125 2-stroke



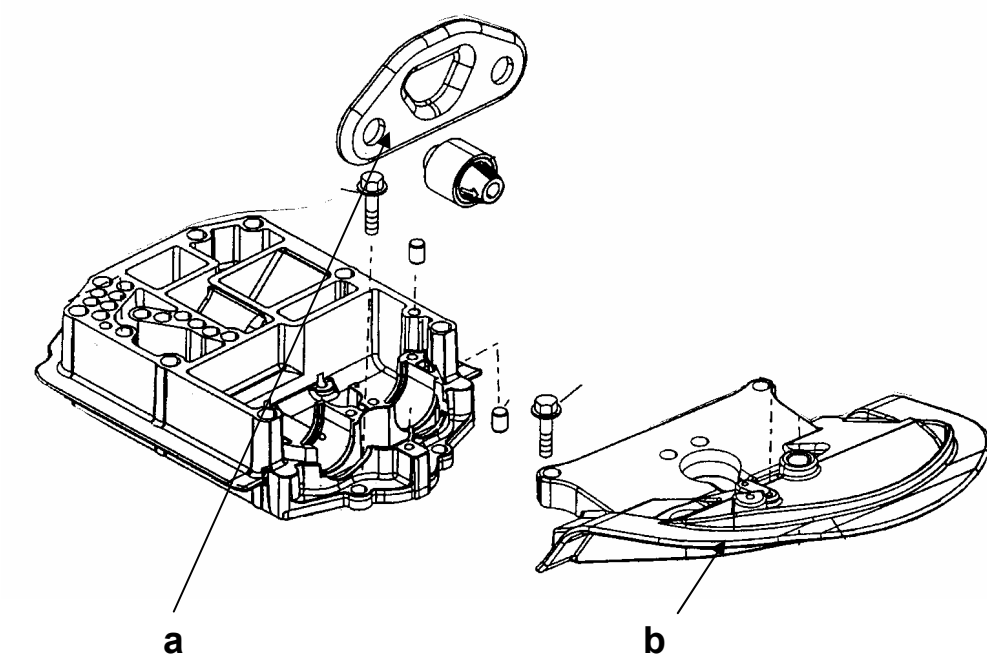
a- Water deflectors (3) installed and removed through pipe plug holes at rear of power head.

Notes

Notes

Mid-Section

- Larger upper and lower mounts
- Integrated upper mount clamp and cowl seal retainer
- Cast in upper mount pockets
- Improved shift shaft clearance
- Upper and lower mount limit bumpers
- Will replace current 75 – 125 HP 2 –stroke midsection
- Clamp and swivel bracket common with current 75 – 125 2-stroke



a - Limit bumper

b - Upper mount clamp and cowl seal retainer

Accessories

1.5L ACCESSORIES:

- Three gallon remote oil tank kit P/N 1257-8742A25
- Tiller handle kit, will not be ready for start of production estimated to be ready late summer 2003.
- Costal Flush kit P/N 858566A02 is a hose that is run out the front of the cowling to attach a hose to flush the engine. This will be standard on salt water version.
- Tilt limit switch kit P/N 87-887979A2. Same switch kit currently used on the 3.0 Liter, with up-dated instruction sheet.
- Analog power trim position sender kit will be standard on later models.
- SmartCraft speedo sensor kit.
- Water pressure gauge “TEE” fitting/hose kit will be standard on later models.
- Tiller handle kits.

GAUGES

- Engine will support all analog gauges except block/water temperature.
- Engine is SmartCraft compatible

Notes

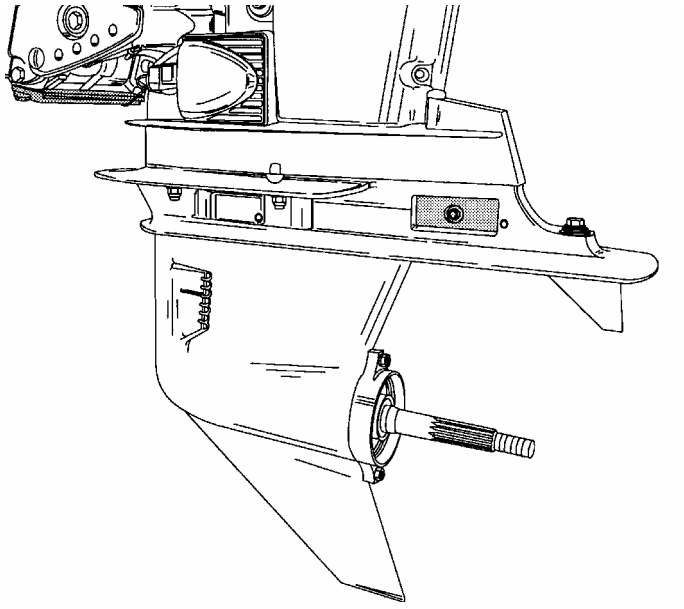
Notes

Power Trim

- Common power trim with current 75 -125 2-stroke
- Analog power trim position sender kit will be standard after S/N 0T846415.

Lower Unit

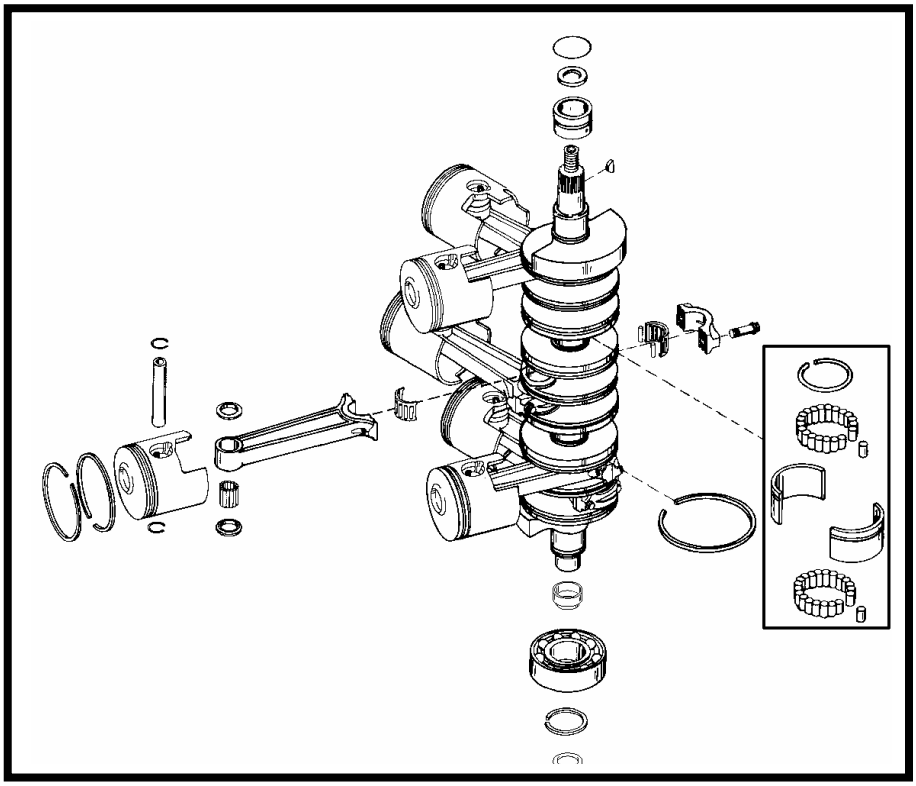
- Gear Ratios
  - 75/90 2.33:1 Teeth 28/12
  - 115 2.07:1 Teeth 29/14
- Internal components common with current 75 – 125 2-stroke, except drive shaft. Drive shaft is longer to get proper driveshaft to crankshaft engagement. Lower unit complete is not interchangeable with current 75 – 125 2-stroke. The pinion gear teeth identification decal will have an LIGHT/GRAY background with BLACK letters, for 1.5 Liter OptiMax engines.
- This engine may see prop rattle when using stainless steel and some aluminum props. Using the Flow Torque III prop hub will eliminate most of the prop rattle.



Performance Gear Lube

2.5L, 3.0L, Verado L4 SC and Verado L6 (at time of print) will receive the Hi-Performance gear lubrication. The V-6 product recommendation in the operations manual will be changed to state the use of the Hi-performance lub.

Section 2 - Powerheads



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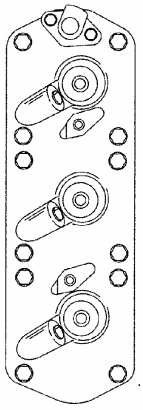
Notes

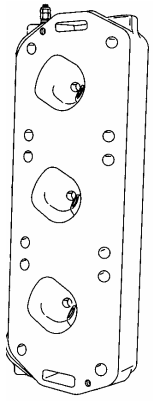
Mechanical Changes to the 2.5L & 3.0L Litre Powerhead

1) Cylinder Head
   a) Direct injector located in the top of the cylinder head.
   b) 5/8” hex, long reach spark plug - puts the tip in the direct injector spray pattern.
   c) Head Gasket Change
      i) 1998/99 2.5L aluminum gasket with o-ring seals
      ii) 1998/99 3.0L & all 2000 models use an o-ring gaskets
2) Pistons
   a) Cupped piston dome - directs fuel/air mixture, from the injector back up towards the spark plug.
   b) Outside profile changed and inside shape contoured to pass heat to skirt and cylinder wall (hotter cylinder temperatures).
   c) Pistons are marked “P” for port and “S” for starboard.
3) Cylinder block
   a) OpitMax block casting has extra mounting points for OpitMax system components – different from standard 2.5L or 3.0L block.

OptiMax Cylinder Head

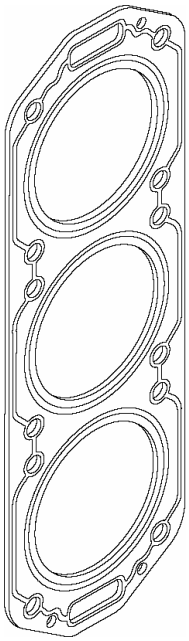


The head is modified to support the fuel/air rails and position the spark plug at the correct location inside the cylinder.



The OptiMax cylinder head utilizes a unique design to help trap the fuel/air mixture for efficient and reliable combustion.

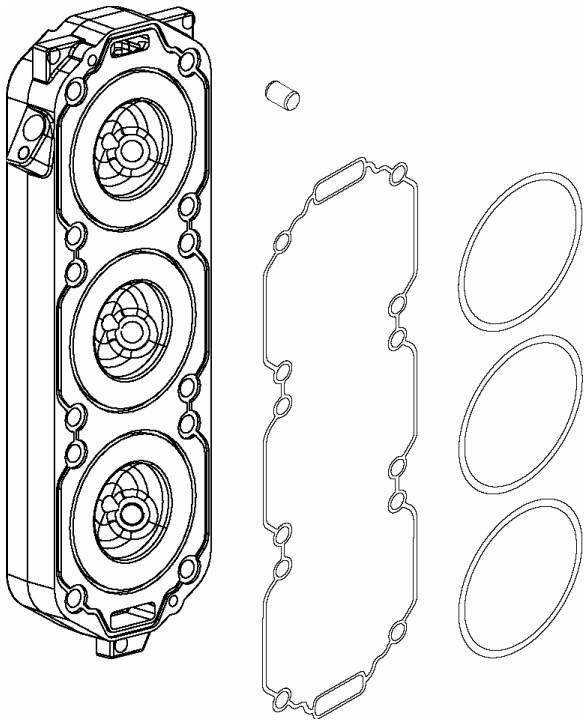
Head Gasket



The 1998/99 2.5L head gasket is aluminum (0.100” thick) with an O-ring type seal on both sides.

2.5L 2000 MODEL YEAR

Cylinder head will incorporate O–ring style head gasket similar to all 3.0 litre V–6 models.



Notes

Notes

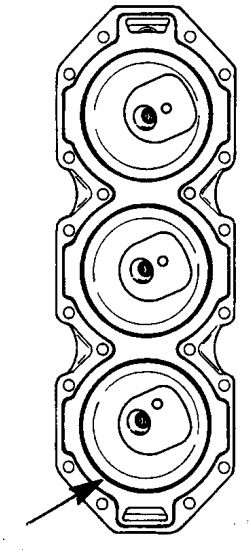
3.0L 2003 MODEL YEAR

CYLINDER BORE O-RINGS

Cylinder bore sealing O-rings have changed size and material. O-ring seals separately will NOT back fit to prior model years.

SIZE: Cylinder head seal is .070 (177mm) smaller in diameter to increase clearance between the water dam and water passages.

MATERIAL: New material has a higher resistance to heat and oils than the present material.

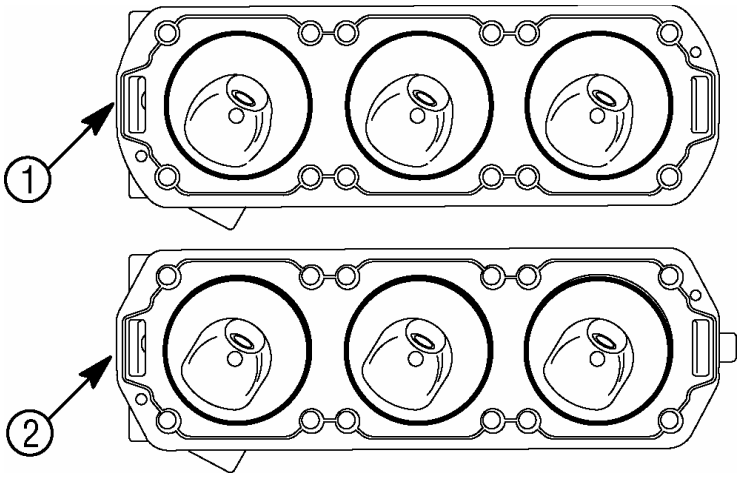


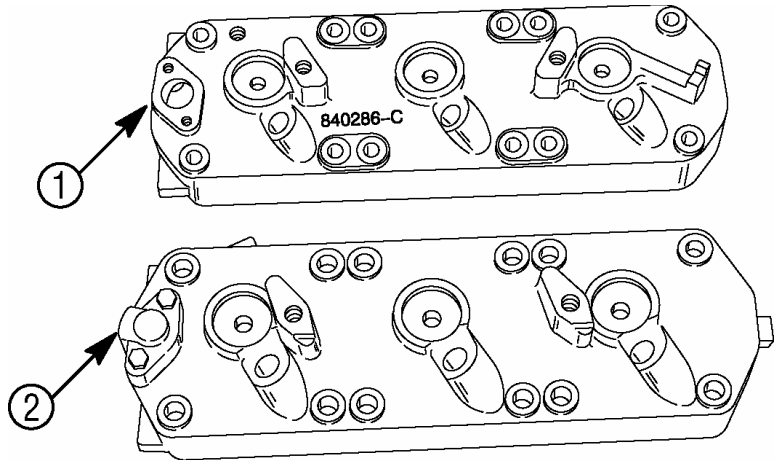
Model 175 Optimax

2001 MY

This engine is based on the 2.5 Litre OptiMax. Differences between 175 HP and the 150 HP, 2.5 Litre OptiMax are:

- ECM calibration
- Head bolts for the 175 heads will be _ inch shorter then the 135 and 150 HP.
- New open chambered cylinder head for increased power.
- Cylinder liners (different porting)
- Added holes in flywheel cover for increased airflow into air plenum to help increase HP. Same cover will be used on 135 and 150 HP; calibration will be changed on these models to keep HP within range.





Notes

Notes

O–Ring Cylinder Head

2001 MY

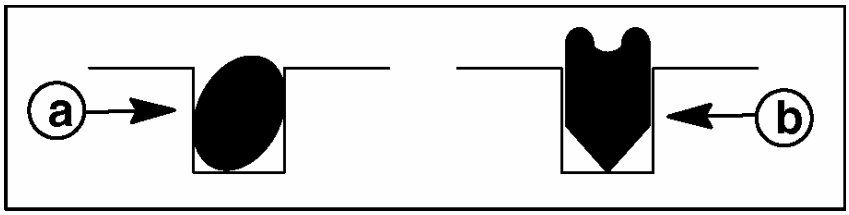
The cylinder head O-ring seals have a new profile/ design. The purpose of this new design is to fill as much of the O-ring groove as possible. This pre-vents oil from accumulating around the O-ring and breaking down the O-ring material.

2.5 Litre

P/N 25-859772 SST
P/N 25-859772-1

3.0 Litre

P/N 25-818573 SST
P/N 25-878453

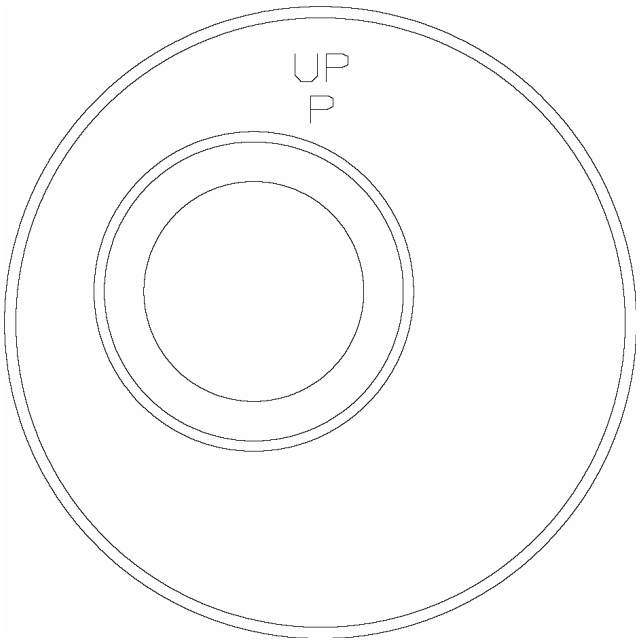


NOTE: Model Year 2000 *– Cylinder head o-rings are oval shaped and are not directional in their installation. O-rings should not be damaged or twisted. Replace as required.*

Model Year 2001 – Cylinder head o-rings are directional in their installation. The grooved side faces the cylinder block. The pointed side faces into the cylinder head. Failure to install the o-rings correctly may result in cylinder head leakage. O-rings should not be damaged or twisted. Replace as required. The 2001 style o-rings supercede and backfit to 2000 Model Year outboards.

Also see “Service Bulletin 2002-13” for more information.

Pistons



The OpitMax piston contains a bowl inside the dome of the piston. The position of the bowl will change between the port and starboard piston.

Notes

Notes

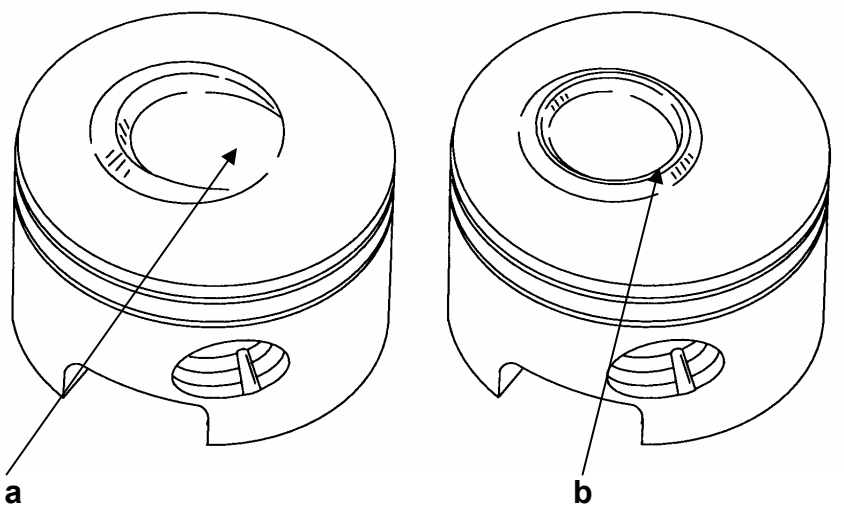
Piston Profile

2003 MY

New piston profile and combustion bowl.

New profile for improved piston fit, and increased durability.

New combustion bowl for improved combustion of fuel charge.

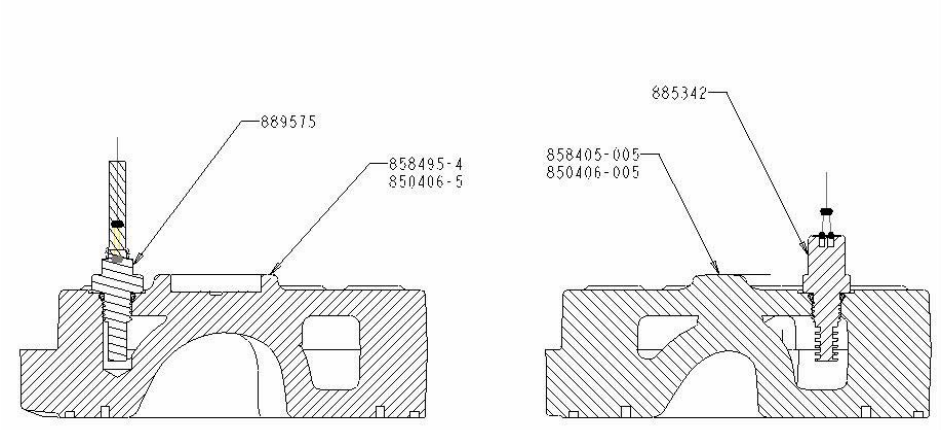


a) – New combustion bowl
b) – Old combustion bowl

Temperature Sensor (Location Change)

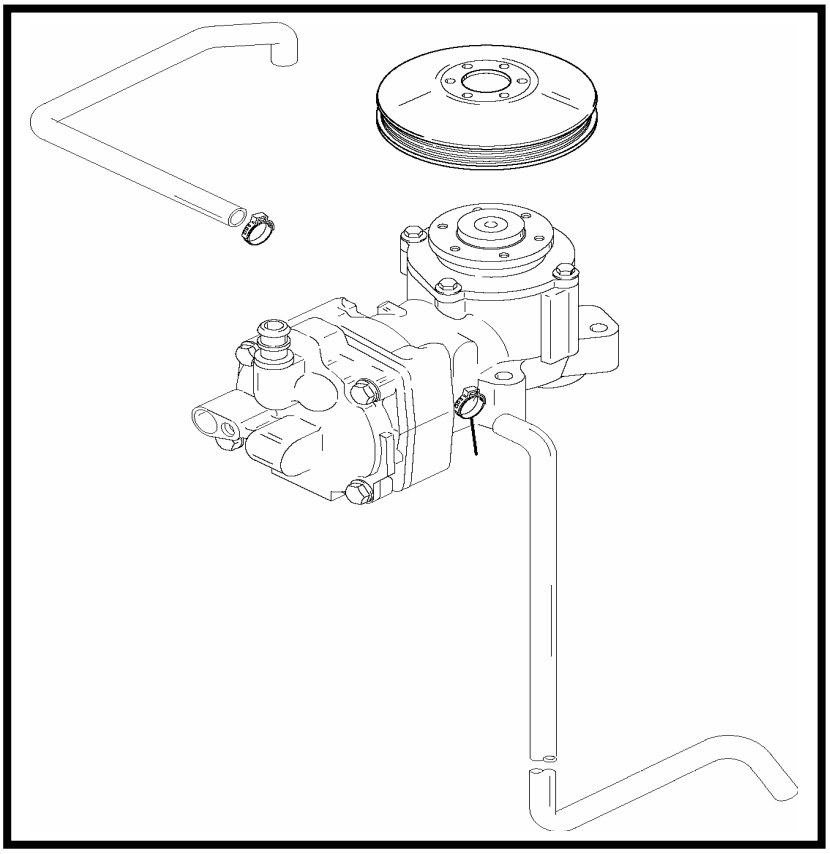
2004 MY

The temperature sensor location was changed to improve water flow around the sensor for a more accurate reading.



OLD LOCATION **NEW LOCATION**

Section 3 - Air System



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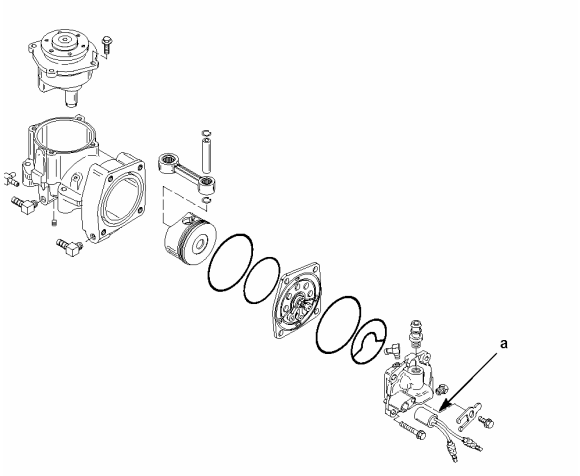
Air Compressor Exploded View



Air Compressor System

DESCRIPTION

- Air from inside the engine cowl is drawn into compressor through the flywheel cover or plenum.
- Flywheel cover contains a filter to prevent ingestion of debris
- A restrictor is located between the filter and the compressor
- Restrictor lowers intake noise
- Restrictor should be removed at altitudes over 5,000 ft
- The compressor is driven by a serpentine belt from the crankshaft
- The air compressor is a single cylinder unit, containing:
- crankshaft
- connecting rod
- piston
- rings
- bearings
- reed valves
- Compressor is water cooled to lower the temperature of the air charge
- Compressor is lubricated by the engine oil pump

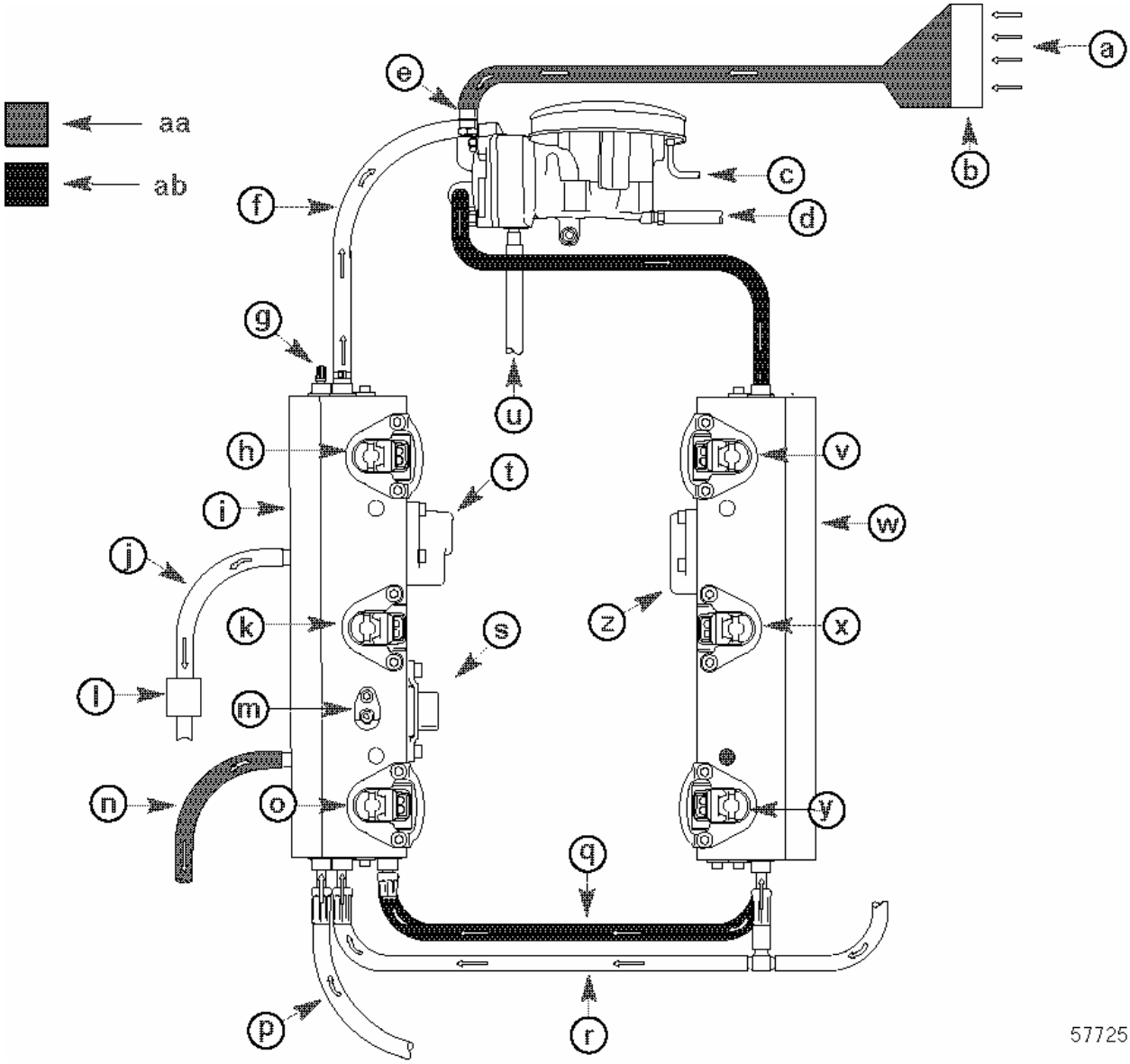
FUNCTION

- Piston moves down, pulling air through the filter & reed valves, into the cylinder
- Piston moves up, intake reeds close & exhaust reeds open, forcing the compressed air into the hose leading to the fuel rails

FLOW

- Air/fuel rails have a fuel passage and an air passage
- Air passage is common between all the cylinders on the rail
- Hoses connect the rails and the air compressor
- The air pressure regulator limits the amount of air pressure in the air passages to about 10 psi below the fuel in the fuel passages
- Air exiting the air pressure regulator is routed to the exhaust adaptor and exits through the propeller

2002 MY and Up- 2.5L Air Compressor Flow Diagram



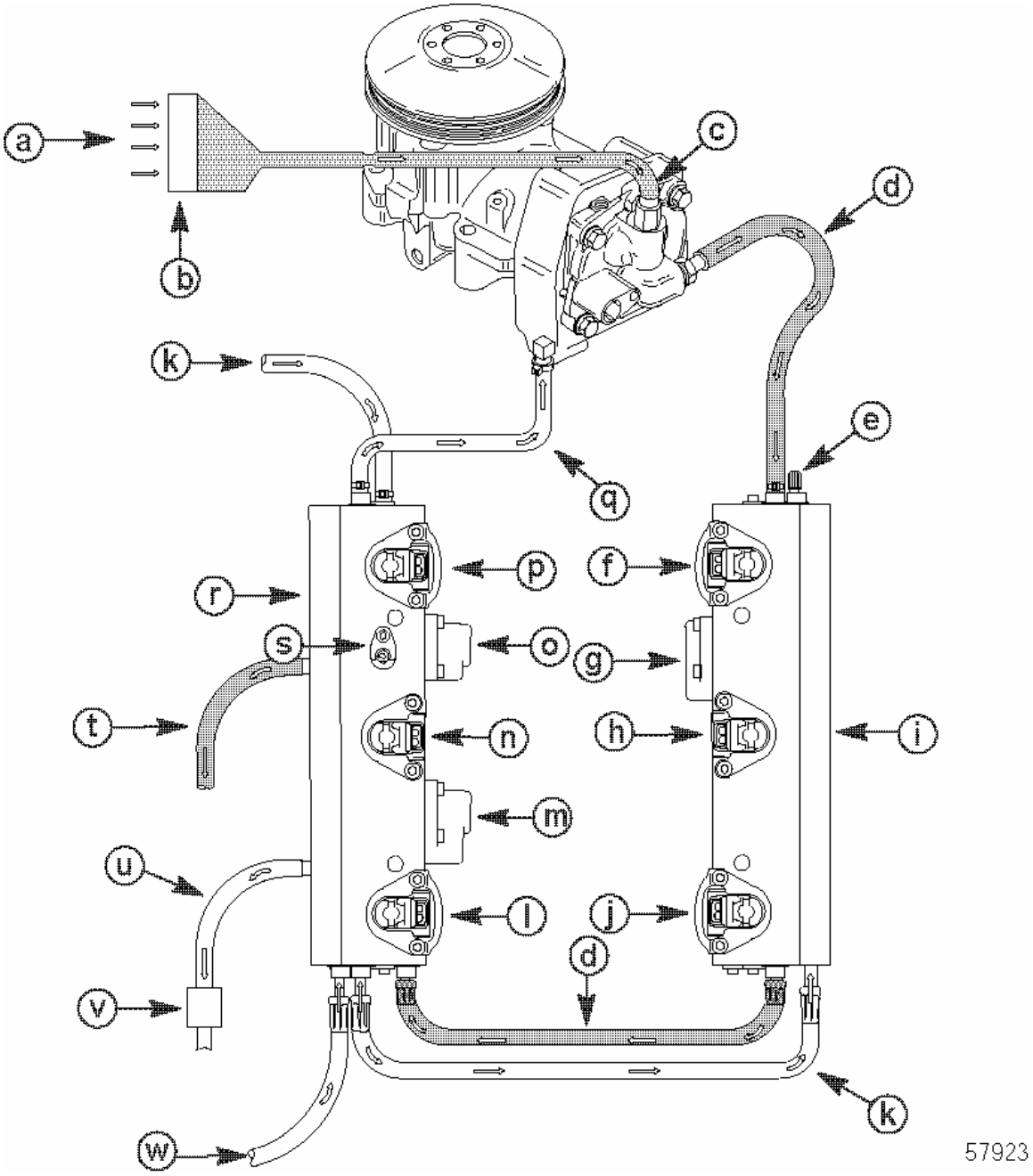
a) Air Inlet
b) Air Filter
c) Compressor Oil Inlet
d) Excess Oil Return
e) Compressor Air Inlet
f) Compressor Water Inlet
g) Fuel System Pressure Test Valve
h) #2 Fuel Injector
i) Port Fuel Rail
j) Excess Fuel Return to VST
k) #4 Fuel Injector
l) 40 psi Check Valve
m) Air Pressure Test Valve
n) Excess Air Return to Exhaust Adaptor Plate
o) #6 Fuel Injector
p) Water Inlet to Fuel Rail
q) Air [79 _ 2 psi (544.0 _ 13.8 kPa)]
r) High Pressure Fuel [89 _ 2 psi (613.5 _ 13.8)]
s) Air Regulator [79 _ 2 psi (544.0 _ 13.8 kPa)]
t) Fuel Regulator [89 _ 2 psi (613.5 _ 13.8)]
u) Water Outlet (tell-tale)
v) #1 Fuel Injector
w) Starboard Fuel Rail
x) #3 Fuel Injector
y) #5 Fuel Injector
z) Tracker
aa) Low Pressure (Air)
ab) High Pressure (Air)

Tip: The Schrader Valve Test Ports have changed by model year. 1998-1999 MY – Air is Port and Fuel is starboard. For 2000 MY and Up – See Service Manual for correct locations.

NOTE: Typical example, component location will vary on other models.

Notes

2002 MY and Up - 3.0L Air Compressor Flow Diagram



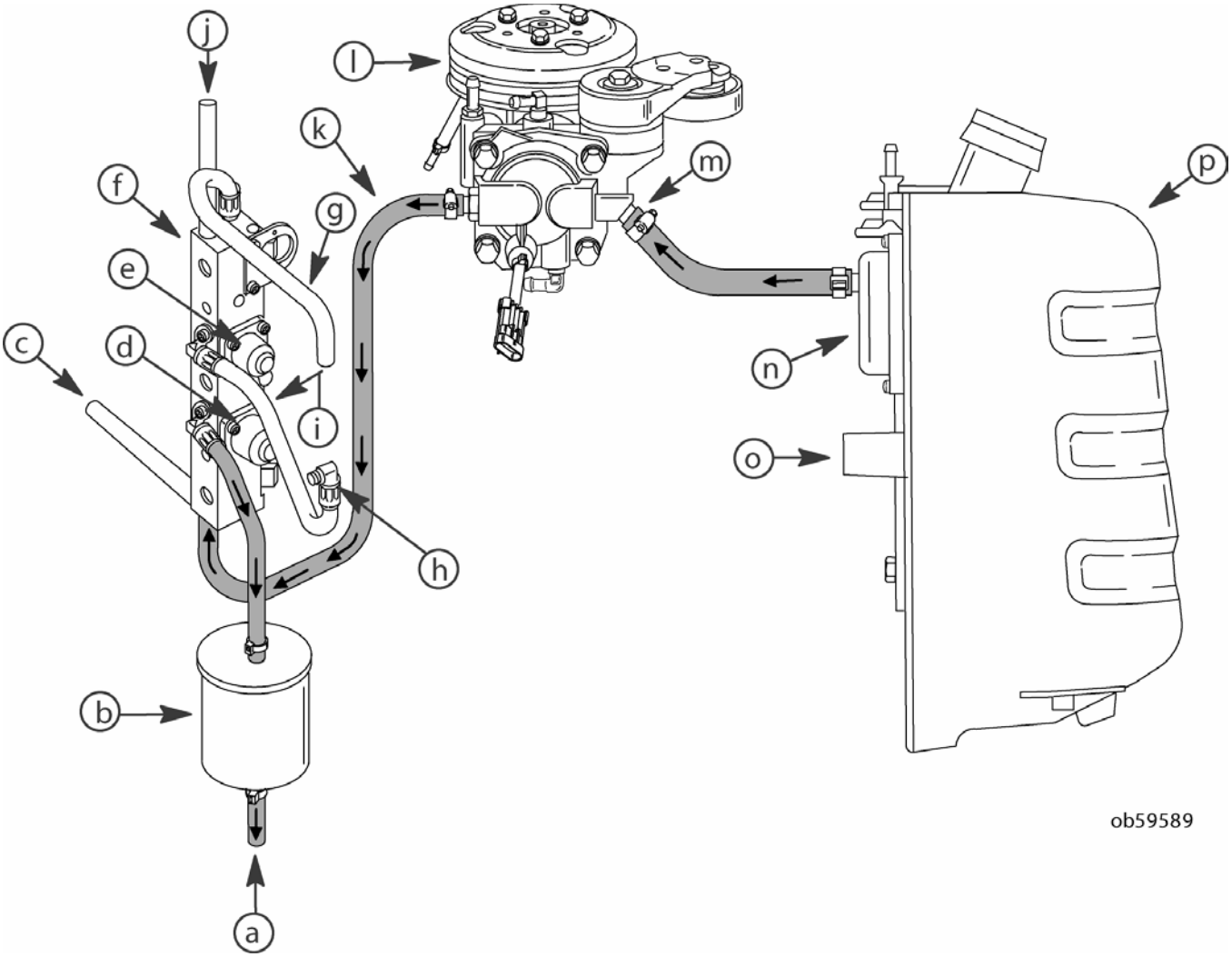
a) Air Inlet
b) Air Filter
c) Compressor Air Inlet
d) Air [79 ± 2 psi (544.0 ± 13.8 kPa)]
e) Fuel System Pressure Test Valve
f) #1 Fuel Injector
g) Tracker Valve
h) #3 Fuel Injector
i) Starboard Fuel Rail
j) #5 Fuel Injector
k) High Pressure Fuel [89 ±2 psi (613.5 ±13.8 kPa)]
l) #6 Fuel Injector
m) Fuel Regulator [89 ±2 psi (613.5 ±13.8 kPa)]
n) #4 Fuel Injector
o) Air Regulator [79 ± 2 psi (544.0 ± 13.8 kPa)]
p) #2 Fuel Injector
q) Compressor Water Inlet
r) Port Fuel Rail
s) Air Pressure Test Valve
t) Excess Air Return to Air Plenum
u) Excess Fuel Return to VST
v) 40 psi Check Valve (Not on All Models)
w) Water Inlet to Fuel Rail

Tip: Air Pressure Specification – 2001 updated 3.0L engines and 2002 MY engines have 82 ± 2 psi air pressure.

Tip: Excess air discharge is either into the air plenum or exhaust adapter plate depending on the model year.

Notes

2004 MY 1.5L Air Compressor Flow Diagram



a - Excess air return to adaptor plate

b - Air muffler

c - Water outlet from fuel rail

d - Air regulator – 648.1 ± 13.8 kPa (94 ± 2 psi)

e - Fuel regulator – 744.6 ± 13.8 kPa (108 ± 2 psi)

f - Fuel rail

g - Fuel inlet to fuel rail – 744.6 ± 13.8 kPa (108 ± 2 psi)

h - Excess fuel return to VST

i - Air pressure test valve (hidden)

j - Water inlet hose to air compressor

k - High pressure air to fuel rail – 648.1 ± 13.8 kPa (94 ± 2 psi)

l - Air compressor

m - Compressor air inlet

n - Air filter

o - Air inlet

p - Oil tank/air attenuator

Notes

Notes

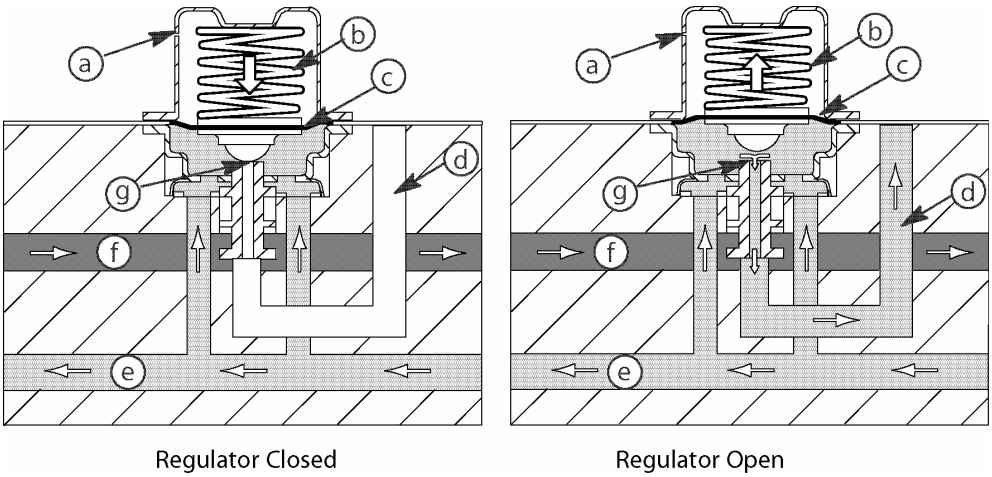
Air Pressure Regulator

The air pressure regulator is designed to limit the air pressure inside the rails to approximately 80 psi (95 psi on 1.5L Models).

The air regulator uses a spring (pressure) to control the air pressure. This spring (80 or 95 psi) holds the diaphragm against the diaphragm seat. The contact area blocks (closes) the air inlet passage from the excess air, return passage. As the air pressure rises (below the diaphragm), it must reach a pressure equal to or greater than the spring pressure holding the diaphragm closed. Once this pressure is achieved, the spring compresses, allowing the diaphragm to move. The diaphragm moves away from the diaphragm seat, allowing air to exit through the diaphragm seat, into the excess air passage leading to the exhaust adaptor plate.

Sectional View

AIR REGULATOR VALVE

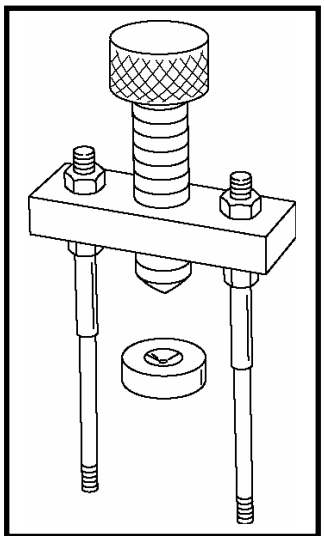


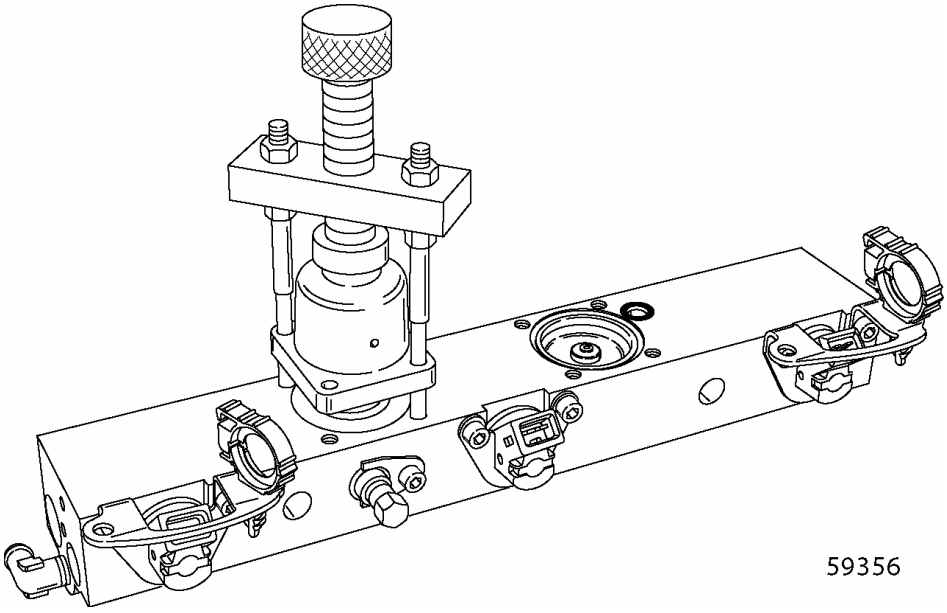
Regulator Closed

Regulator Open

a - Vent hole
b - 80 lb. spring (95 lb. spring on 1.5L model)
c - Diaphragm
d - Air dump
e - Fuel passage
f - Air passage
g - Air vent opening

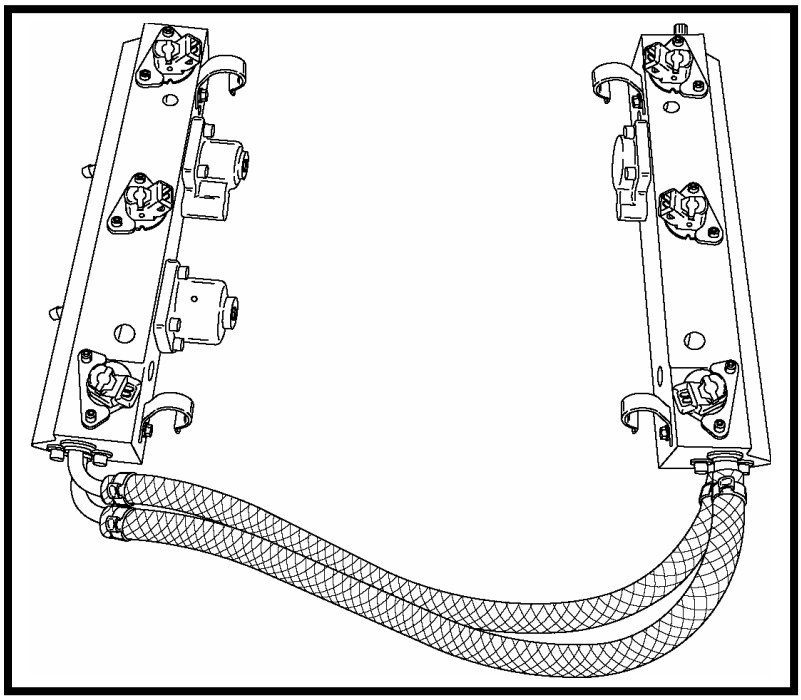
Air Regulator Tool – P/N 91-889431





Notes

Section 4 - Fuel System



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Notes

Powerhead Long Term Storage

Storage Preparation

The major consideration in preparing your outboard for storage is to protect it from rust, corrosion, and damage caused by freezing of trapped water.

The following storage procedures should be followed to prepare your outboard for out of season storage or prolonged storage (two months or longer).

CAUTION
Never start or run your outboard (even momentarily) without water circulating through all the cooling water intake holes in the gear case to prevent damage to the water pump (running dry) or overheating of the engine.

FUEL SYSTEM

IMPORTANT: Gasoline containing alcohol (ethanol or methanol) can cause a formation of acid during storage and can damage the fuel system. If the gasoline being used contains alcohol, it is advisable to drain as much of the remaining gasoline as possible from the fuel tank, remote fuel line, and engine fuel system.

Fill the fuel system (tank, hoses, fuel pumps, and fuel injection systems) with treated (stabilized) fuel to help prevent formation of varnish and gum. Proceed with following instructions.

1) Portable Fuel Tank – Pour the required amount of Quicksilver Gasoline Stabilizer (follow instructions on container) into fuel tank. Tip fuel tank back and forth to mix stabilizer with the fuel.
2) Permanently Installed Fuel Tank – Pour the required amount of Quicksilver Gasoline Stabilizer (follow instructions on container) into a separate container and mix with approximately one quart (one liter) of gasoline. Pour this mixture into fuel tank.
3) Place the outboard in water or connect flushing attachment for circulating cooling water. Run the engine at 2000 rpm for 25 minutes to allow treated fuel to fill the fuel system.

PROTECTING INTERNAL ENGINE COMPONENTS

NOTE: *Make sure the fuel system has been prepared for storage.*

1) Remove the spark plugs and add approximately one ounce (30ml) of engine oil into each spark plug hole. Rotate the flywheel manually several times to distribute the oil in the cylinders. Reinstall spark plugs.
2) Remove the water separating fuel filter and empty contents into a suitable container. Refer to Maintenance Section for removal and installation of filter. Replace fuel filter annually, or every 100 Hours of operation, or if large amount of fuel contamination is present.

FUEL ADDITIVE RECOMMENDATION (QUICKLEEN)

See Service Bulletin 2001-12

Today's OptiMax engine control systems allow only minute quantities of air and fuel to reach the combustion chamber in order to produce minimal emissions. But, these diminutive amounts of air and fuel are easily obstructed by fuel injector, direct injector and combustion chamber deposits. Due to the inconsistent fuel quality in some areas, excessive fuel system and combustion chamber deposits are on the rise. These deposits cause many driveability problems that range from hesitation, rough idle, spark plug fouling, to detonation problems. This performance characteristic can be prevented through fuel system maintenance.

To minimize fuel system, and carbon deposit buildup in the engine, we recommend adding Mercury or Quicksilver Quickleen P/N 92-802877A1 Engine Treatment additive to your engine's fuel at each tank fill, throughout the boating season. Use additive as directed on the container.

PROTECTING EXTERNAL OUTBOARD COMPONENTS

1) Lubricate all outboard components listed in the Inspection and Maintenance Schedule.
2) Touch up any paint nicks. See your dealer for touch-up paint.
3) Spray Quicksilver Corrosion Guard on external metal surfaces (except corrosion control anodes).

GEAR CASE

Drain and refill the gear case lubricant (refer to maintenance procedure).

POSITIONING OUTBOARD FOR STORAGE

Store outboard in an upright (vertical) position to allow water to drain out of outboard.

CAUTION
If outboard is stored tilted up in freezing temperature, trapped cooling water or rain water that may have entered the propeller exhaust outlet in the gear case could freeze and cause damage to the outboard.

BATTERY STORAGE

1) Follow the battery manufacturers instructions for storage and recharging.
2) Remove the battery from the boat and check water level. Recharge if necessary.
3) Store the battery in a cool, dry place.
4) Periodically check the water level and recharge the battery during storage.

Notes

Notes

Fuel Starvation

See Service Bulletin 2001-17

Models Affected

MERCURY/MARINER

1987 and Later, 30 Thru 250 HP, (with square fuel pump)

FORCE

1994-1/2 and later 40 Thru 120 HP, 1997 and later 175 Sport Jet

It is important that fuel supply restrictions/vacuum levels do not exceed specification. High restrictions may result in the engine stalling at low speed, and /or a lean fuel condition at high RPM, that could cause non-warrantable engine damage. It is recommended to check fuel system vacuum on all new boats/engines being prepared for delivery to ensure customer satisfaction and engine durability.

Inspection/Test

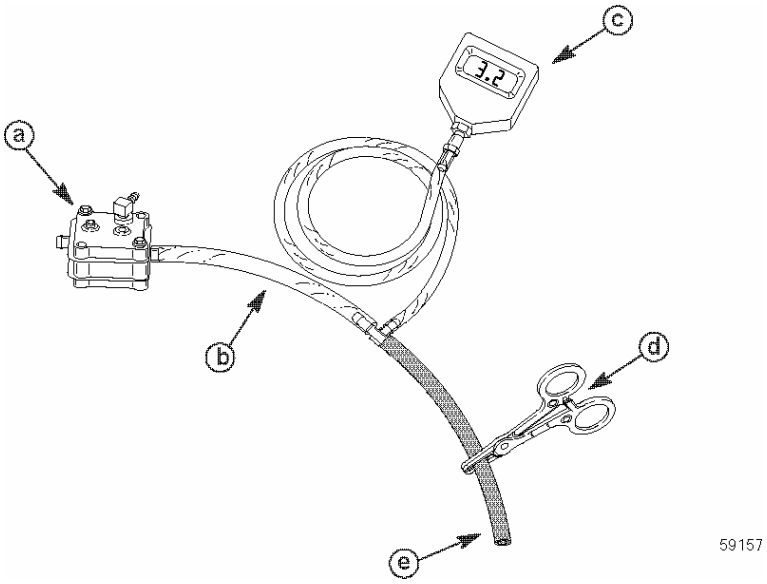
The purpose of the following tests is to check the vacuum level required to draw fuel from the fuel tank to the pulse driven fuel pump, check for air leaks in the fuel supply system, and the condition of the pulse driven pump. The following items will be required to perform these tests.

- Short piece of clear hose ¼" .250 [6.35mm] I.D.
- Vacuum gauge, (digital gauge is preferred) obtain locally
- "TEE" fitting that will fit ¼" .250 [6.35mm] I.D. fuel hose
- Tubing clamp P/N 91-804063

Make vacuum gauge, "TEE" fitting, and hose connection as shown.

NOTE: *Prior to performing the following tests, squeeze the primer bulb to determine if thereis sufficient lift capability. If engine runs, confirm this by performing the tests on the following page.*

NOTE: *Make the "TEE" fitting connection as close to the fuel pump as possible.*



a) Pulse driven fuel pump
b) Clear hose connected between pulse pump and "TEE" fitting
c) Vacuum gauge (digital)
d) Tubing clamp P/N 91-804063
e) Fuel supply hose from fuel tank

Test Procedure

Notes

PUMP CAPABILITY TEST

Before proceeding with the system vacuum test, confirm that the pulse fuel pump is capable of supplying the required vacuum. To do this, start the engine and run at idle speed, pinch off/restrict the fuel supply hose between the vacuum gauge and fuel tank, using tubing clamp.

Normal Reading	2.5 in. of vacuum (mercury) or higher, proceed to fuel system leak test.

Reading below 2.5 in. vacuum (mercury)	• Pump check valves defective, replace valves • Pump diaphragm defective, replace diaphragms • Air leak in pump, rebuild pump with new gasket, • check fitting for leaks • Low crankcase pressure, check for crankcase • leaks or plugged pulse pump pressure/vacuum • passageways.

FUEL SYSTEM LEAK TEST

This test is done with the engine running, and the tubing clamp removed. The clear hose that was installed previously is used to view the fuel flow to the pulse pump.

No air bubbles seen in clear hose	No air leaks, perform vacuum test (following)

Air bubbles seen in clear hose	Air leak on intake side of fuel system • Pick up tube in fuel tank leaking • Outlet fitting at fuel tank leaking • Fuel inlet hose not properly clamped at fitting • Leaking fuel tank valve • Fuel line from kicker engine connected into fuel line of main engine.

Notes

VACUUM TEST

The system vacuum test is normally performed at an idle speed. As engine RPM increases, there will be a slight increase in vacuum; this increase should not exceed normal readings at any RPM.

Normal Reading	Below 2.5 in. of Vacuum (mercury)

Reading above 2.5 in. of vacuum (mercury)	Restriction within the fuel system • Restricted anti-siphon valve • Restricted or malfunctioning primer bulb • Kinked or collapsed fuel hose • Plugged water separating fuel filter (in the boat) • Restriction in fuel line thru-hull fitting • Restriction in fuel tank switching valves • Plugged fuel tank pick-up screen

Correction:

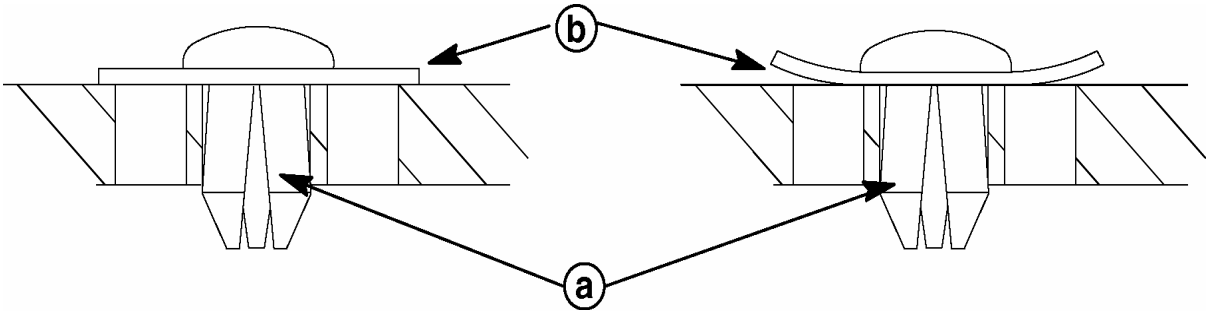
If the fuel capability test indicated good vacuum level (2.5 in. mercury or higher) proceed to PRIMER BULB replacement.

If the fuel pump capability test indicate low vacuum, proceed with the following two upgrades to the fuel system to prevent low speed stalling.

PULSE FUEL PUMP:

The new repair kits contain check valves made of a plastic material, impervious to damage from fuel additives. When repairing the fuel pump discard old rubber and small plastic check valve disks, and install one new plastic disk under each retainer. Caution must be taken not to push the check valve retainer too tightly against the check valve, this may cause the valve to deform.

NOTE: *Before driving the check valve pin into the retainer, support the pump housing on the opposite side, directly below the check valve retainer using a socket or spacer. This will prevent distortion or cracking of the pump housing.*



CORRECT **INCORRECT**

a) Check Valve Retainer
b) Check Valve

The new plastic check valve started in production at the serial numbers listed below:

MERCURY/MARINER	USA	BELGIUM
200-225 HP, 3.0L Carb/EFI/OptiMax	0G925400	
135-200 HP, 2.0/2.5L Carb/EFI/OptiMax	0G912213	
75-125 HP, 65 Jet	0G923899	0P054758
40-60 HP	0G919929	0P054357
30-40 HP	0G919618	0P054357

Notes

PULSE FUEL PUMP RUNING CHANGE

There is continued improvement planned for the square pulse driven fuel pump used on most of the larger 2 stroke outboards.

CHECK VALVE CONTACT SURFACE: The outer edge of the check valve will contact a raised surface that improves sealing of the valve.

RAISED CENTER PORTION: The center portion of the check valve surface in the pump housing has been raised. This will allow more clearance for debris to pass through the check valve and pump.

RETAINER HOLE CHAMFER TOP SIDE: Currently the retainer head side of the retainer hole has a slight chamfer. This sometimes causes the retainer head to pull the check valve into this chamfer causing the outside edge of the check valve to raise up which prevents good sealing of the valve.

RETAINER HOLE CHAMFER BOTTOM SIDE: The bottom side of the retainer hole will have a chamfer added, this allows the split end of the retainer to spread out without pulling down with excessive force. When there is too much down pressure on the head of the rivet, the outside edges of the check valve is raised up preventing good sealing.

RETAINER O-RING: An O-ring will be added under the retainer head, to prevent leakage past the retainer.

a **b**

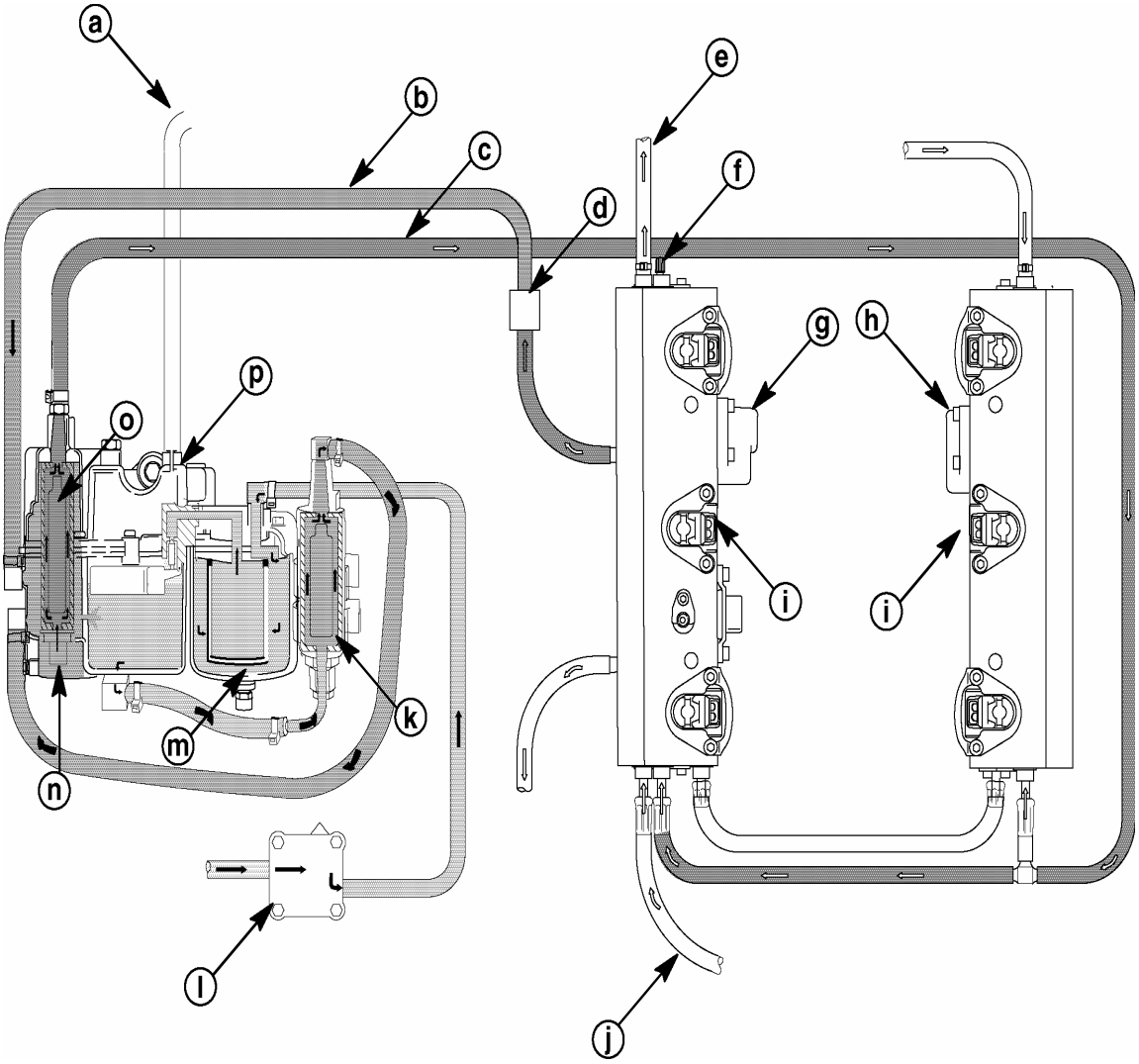
Notes

Basic Fuel System Description

Fuel for the engine is stored in a typical fuel tank. A primer bulb is installed into the fuel line to allow priming of the fuel system. A crankcase mounted pulse driven diaphragm fuel pump draws fuel through the fuel line, primer bulb, fuel pump assembly and then pushes the fuel thru a water separating fuel filter. This filter removes any contaminates and water before the fuel reaches the vapor separator. Fuel vapors are bled into the air compressor inlet in the front of the flywheel cover preventing a vapor lock of the electric fuel pump assembly which is mounted in the vapor separator. The electric fuel pump is different than the fuel pump that is utilized on the standard EFI engine (non DFI), and is capable of developing fuel pressures in excess of 90 psi. Fuel inside the rail must remain pressurized at exactly 10 psi over the air rail pressure or the ECM (map) calibrations will be incorrect. Fuel from the vapor separator is supplied to the top of one fuel rail. A fuel line connects the bottom of the first rail to the opposite fuel rail. Fuel is stored inside the rail until an injector opens. A fuel pressure regulator controls pressure in the fuel rails, and allows excess fuel to return into the vapor separator. The fuel regulator not only regulates fuel pressure but also regulates it at approximately 10 p.s.i. higher than whatever the air rail pressure is. The fuel regulator diaphragm is held closed with a spring that requires 10 p.s.i. to force the diaphragm off the diaphragm seat. The back side of the diaphragm is exposed to air rail pressure. As the air rail pressure increases, the fuel pressure needed to open the regulator will equally increase. Example: If there is 50 p.s.i. of air pressure on the air rail side of the diaphragm, 60 p.s.i. of fuel pressure will be required to open the regulator. The return fuel line to the vapor separator is water cooled. This design is used to prevent cold fuel from the fuel tank hitting the hot fuel returning from the fuel rail and flashing off the light ends (boiling over).

To equalize the pulses developed by the pumps (both air and fuel) a tracker diaphragm is installed in the starboard rail. The tracker diaphragm is positioned between the fuel and air passages. The tracker diaphragm is a rubber diaphragm which expands and retracts depending upon which side of the diaphragm senses the pressure increase (pulse).

2.5L OptiMax Fuel Schematic

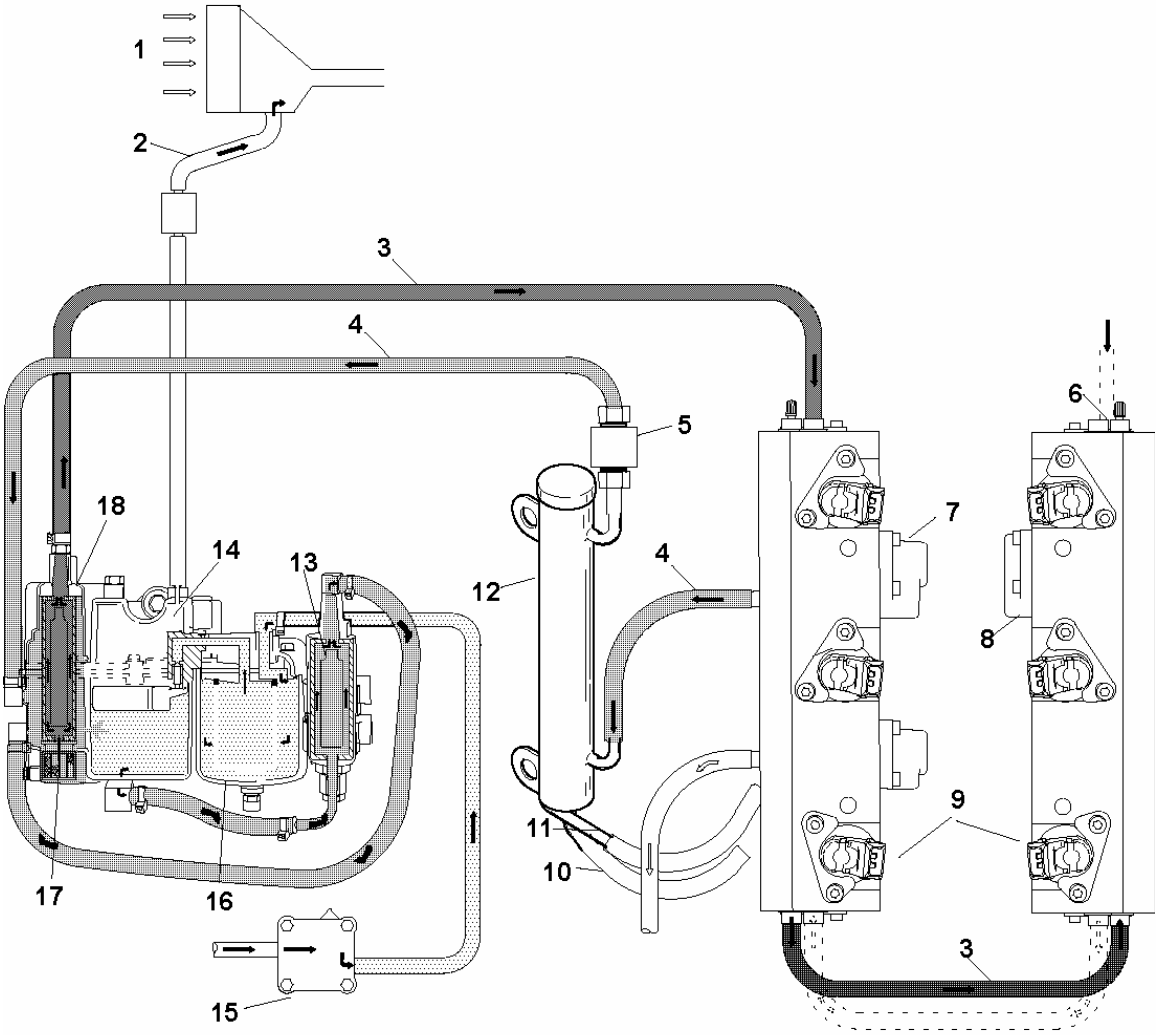


a) Fuel Vapor (to plenum intake cover)
b) Fuel Return
c) High Pressure Fuel
d) 40 psi (subject to change later models) Check Valve
e) Water Outlet to Compressor
f) Fuel System Pressure Test Valve
g) Fuel Regulator
h) Tracker
i) Fuel Injector
j) Water In
k) Low Pressure Electric Fuel Pump
l) Mechanical Fuel Pump
m) Water Separating Fuel Filter
n) Fuel Filter
o) High Pressure Fuel Pump
p) Vapor Separator Tank (VST)

NOTE: *Typical example, component location will vary on other models.*

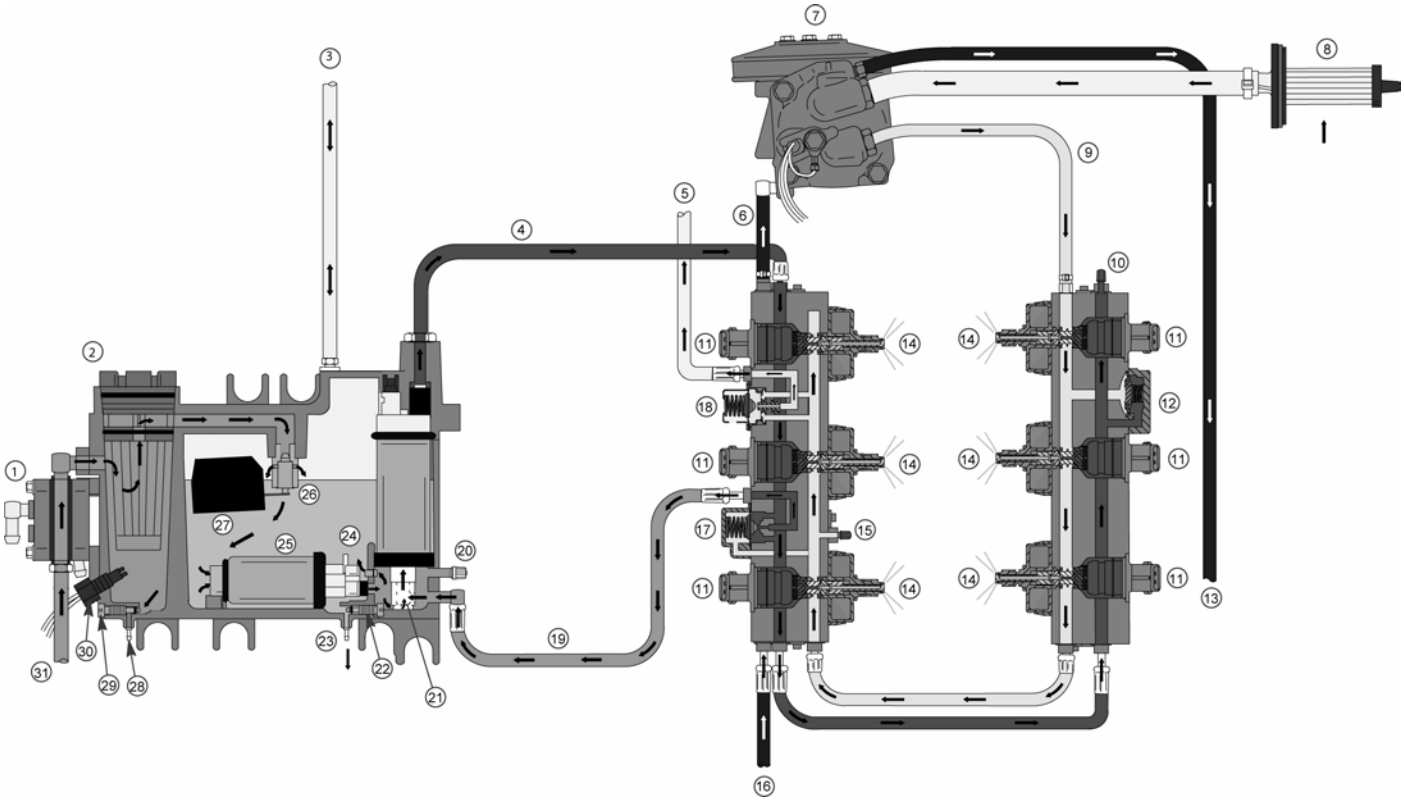
Tip: A stuck 40 psi check valve will result in higher than normal fuel pressure.

OptiMax DFI Fuel Schematic w/Fuel Cooler



1) Air Inlet Compressor
2) Fuel Vapor
3) High Pressure Fuel (90 psi)
4) Fuel Return
5) 40 psi Check Valve
6) Fuel System Pressure Test Valve
7) Fuel Regulator
8) Tracker
9) Fuel Injector
10) Water Out
11) Water In
12) Fuel Cooler
13) Low Pressure Electric Fuel Pump (10 psi)
14) Vapor Separator
15) Mechanical Fuel Pump (10 psi)
16) Water Separating Fuel Filter
17) Fuel Filter
18) High Pressure Fuel Pump

3.0L OptiMax Fuel Schematic



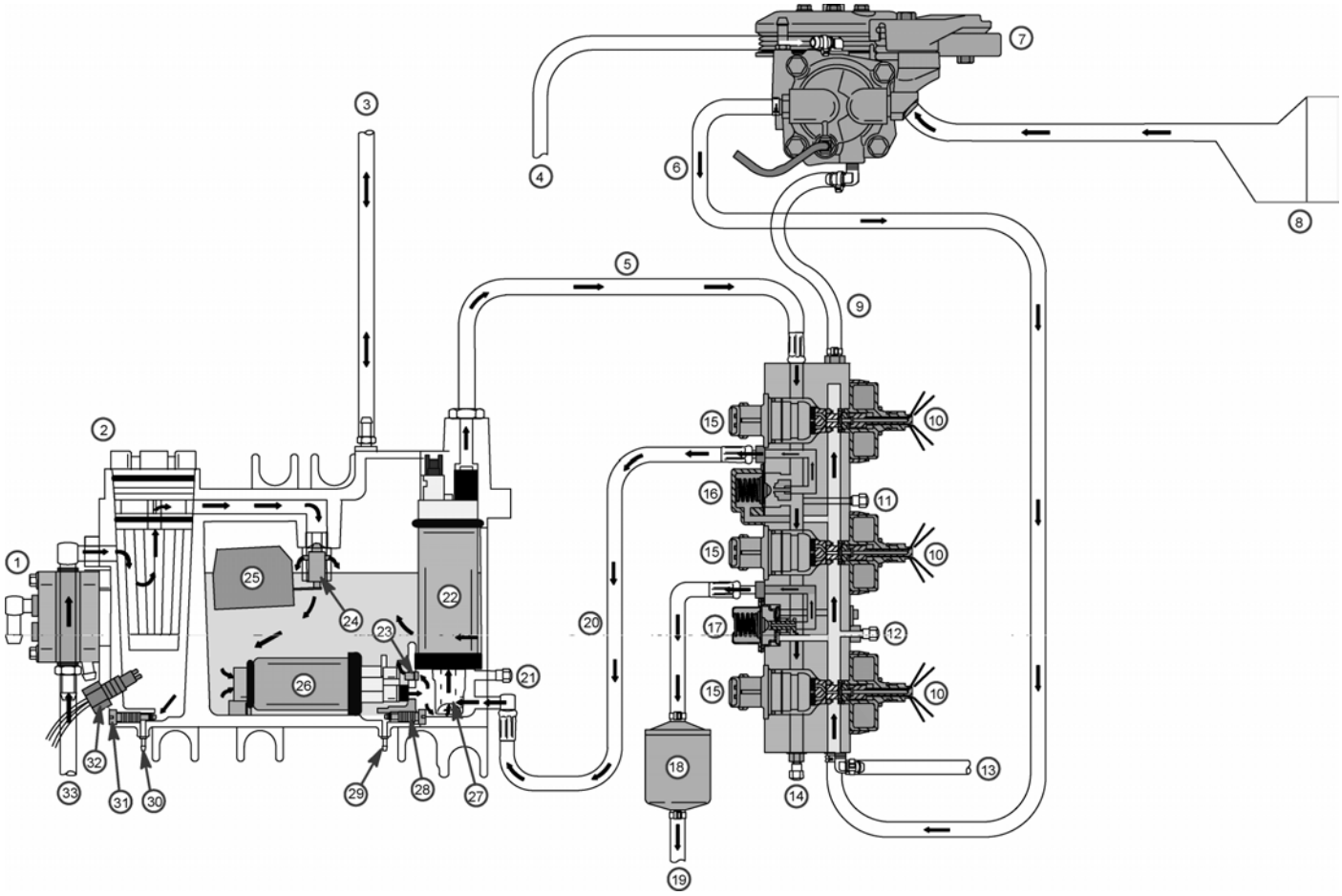
VST History

Fuel cooler with VST	1998/99
Water cooled fuel rail with VST	2000-2002
Water cooled fuel rail with IVST (shown above)	2003 and above

3.0L OptiMax Fuel Schematic (Cont.)

1. Engine Pulse Fuel Pump
2. Fuel/Water Separator Filter
3. Vapor Separator Tank Vent Hose
4. Fuel Outlet from High Pressure Electric Fuel Pump – 620 kPa (90 psi)
5. Bleed Off from Air Pressure Regulator; routed to exhaust adaptor and exits through the propeller
6. Air Compressor Inlet Coolant Hose
7. Air Compressor
8. Air Compressor Inlet Air Filter
9. High Pressure Air Outlet – 551 kPa (80 psi)
10. Schrader Valve for testing fuel pressure – 620 kPa (90 psi)
11. Fuel Injector is opened by the ECM/PCM, 620 kPa (90 psi) fuel is discharged into a machined cavity inside the air chamber of the air/fuel rail. This mixes fuel with the air charge.
12. Tracker Valve has a rubber diaphragm which expands and retracts to equalize the pulses developed by the pumps [both air and fuel].
13. Cooling water routed from air compressor to tell-tale
14. Direct Injector discharges the air/fuel mixture into the combustion chamber
15. Schrader Valve for testing air pressure – 551 kPa (80 psi)
16. Water Inlet to cool port air/fuel rail and air compressor
17. Fuel Pressure Regulator not only regulates fuel pressure but also regulates it at approximately 69 kPa (10 psi) higher than whatever the air rail pressure is. The fuel regulator diaphragm is held closed with a spring that requires 69 kPa (10 psi) to force the diaphragm off the diaphragm seat. The backside of the diaphragm is exposed to air rail pressure. As the air rail pressure increases, the fuel pressure needed to open the regulator will equally increase.
18. Air Pressure Regulator will limit the amount of pressure developed inside the air passages to approximately 69 kPa (10 psi) below the pressure of the fuel inside the fuel passages
19 Bleed off from fuel pressure regulator; routed back to vapor separator tank.
20. Low Pressure Electric Fuel Pump Schrader Valve
21. Fuel Director
22. Vapor Separator Tank Drain Screw
23. Vapor Separator Tank Drain Fitting
24. 172 kPa (25 psi) relief valve
25. Low Pressure Electric Fuel Pump
26. Vapor Separator Tank Float Needle
27. Vapor Separator Tank Float
28. Fuel/Water Drain Fitting
29. Fuel/Water Drain Screw
30. Fuel/Water Sensor
31. Fuel Inlet from primer bulb

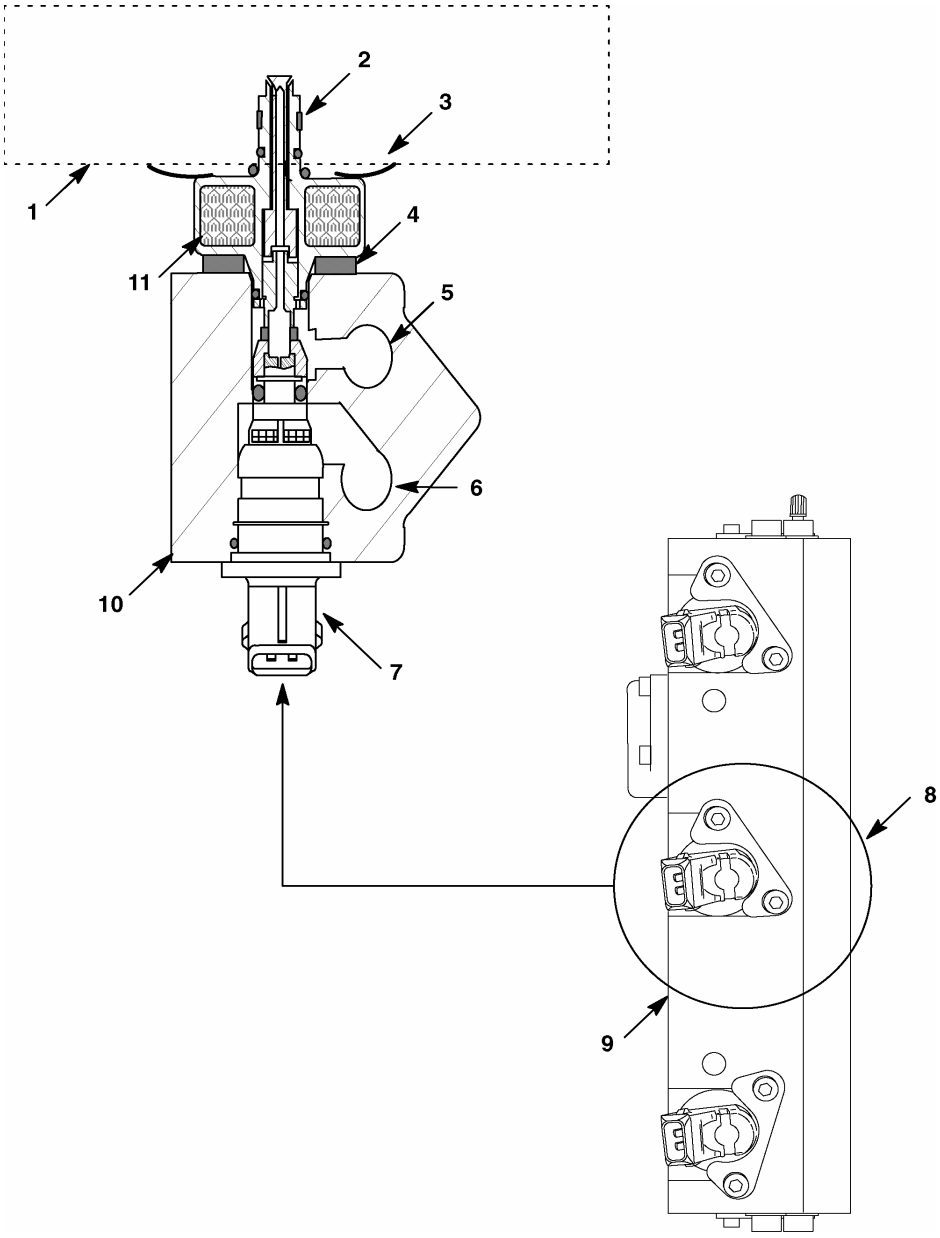
OptiMax 1.5L Fuel Schematic



1. Engine pulse fuel pump
2. Fuel/Water separator filter
3. Vapor separator tank vent hose
4. Air compressor inlet coolant hose
5. Fuel outlet from high pressure electric fuel pump – 751.5 kPa (109 psi)
6. High pressure air outlet – 655 kPa (95 psi)
7. Air compressor
8. Air compressor inlet air filter
9. Cooling water routed from air compressor to fuel rail
10. Direct injector discharges the air/fuel mixture into the combustion chamber
11. Schrader valve for testing fuel pressure (design 2 location) – 571.5 kPa (109 psi)
12. Schrader valve for testing air pressure – 655 kPa (95 psi)
13. Water outlet to tell-tale
14. Schrader valve for testing fuel pressure (design 1 location) – 751.5 kPa (109 psi)
15. Fuel injector is opened by the PCM, 751.5 kPa (109 psi) fuel is discharged into a machined cavity inside the air chamber of the air/fuel rail. This mixes fuel with the air charge.
16. Fuel pressure regulator
17. Air pressure regulator
18. Excess high pressure air muffler
19. Bleed off from air pressure regulator; routed to the outside through bottom cowl
20. Bleed off from fuel pressure regulator; routed back to vapor separator tank.
21. Low pressure electric fuel pump Schrader valve
22. High pressure electric fuel pump
23. 172 kPa (25 psi) relief valve
24. Vapor separator tank float needle
25. Vapor separator tank float
26. Low pressure electric fuel pump
27. Fuel Director
28. Vapor separator tank drain screw
29. Vapor separator tank drain fitting
30. Fuel/Water Drain Fitting
31. Fuel/Water Drain Screw
32. Fuel/Water sensor
33. Fuel Inlet from primer bulb

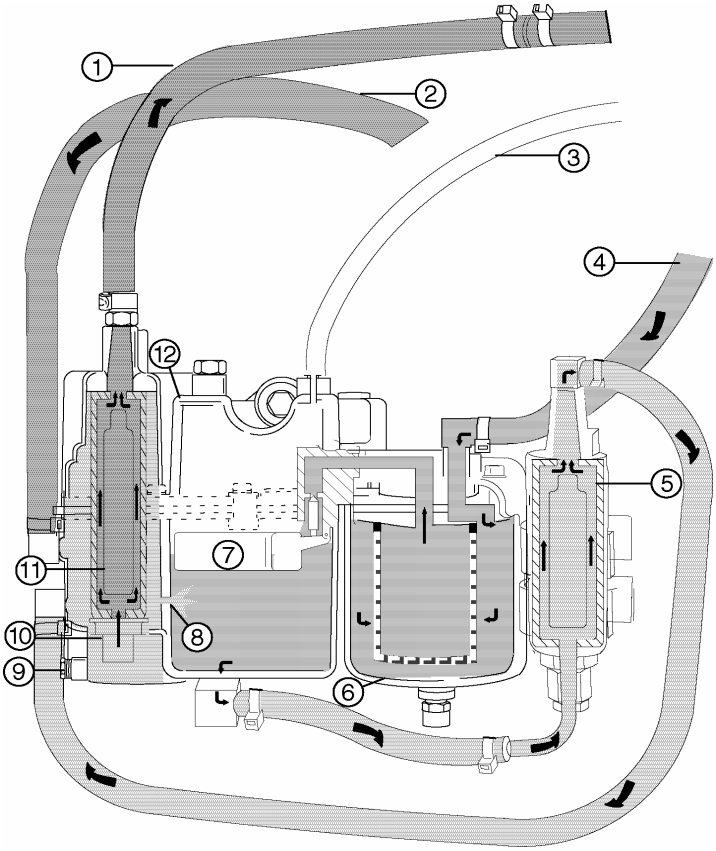
Notes

OptiMax Fuel and Direct Injector Interface



1) Cylinder Head
2) Nylon Seal
3) Bellville Washer
4) Cork Gasket
5) Air Passage
6) Fuel Passage
7) Fuel Injector
8) Area of Detail
9) Air Fuel Rail
10) Fuel Injector
11) 1Direct Injector

Vapor Separator Fuel Flow



1) High Pressure Fuel (to Air/Fuel Rail)
2) Return Fuel (from Air/Fuel Rail) [on 3.0L models this hose connection point (on VST) is reversed with low pressure fuel pump hose connection point.]
3) Vent Tube (to Flywheel Cover)
4) Fuel Inlet (from Pulse Driven Fuel Pump)
5) Low Pressure Fuel Pump
6) Water Separating Fuel Filter
7) Float
8) Fuel Return Orifice
9) Drain Plug
10) Filter
11) High Pressure Fuel Pump
12) Vapor Separator

The low pressure electric fuel pump was added, to eliminate vapor locking of the fuel system. This pump draws fuel from the main chamber of the vapor separator, and pushes the fuel into the chamber (in the vapor separator) where the high pressure electric fuel pump is located. This creates a pressure of about 6 to 7 psi on the input side of the high pressure fuel pump. The extra fuel in this chamber returns to the main vapor separator chamber through a 0.030 hole. By maintaining this low pressure on the input side of the high pressure fuel pump any potential vapor lock is eliminated.

Notes

Notes

Integrated Vapor Separator

2003 MY

Improved low pressure electric fuel pump for improved durability

Low pressure electric pump enclosed in the IVST, simplified fuel hose routing.

Pulse pump built onto IVST to simplify hose routing.

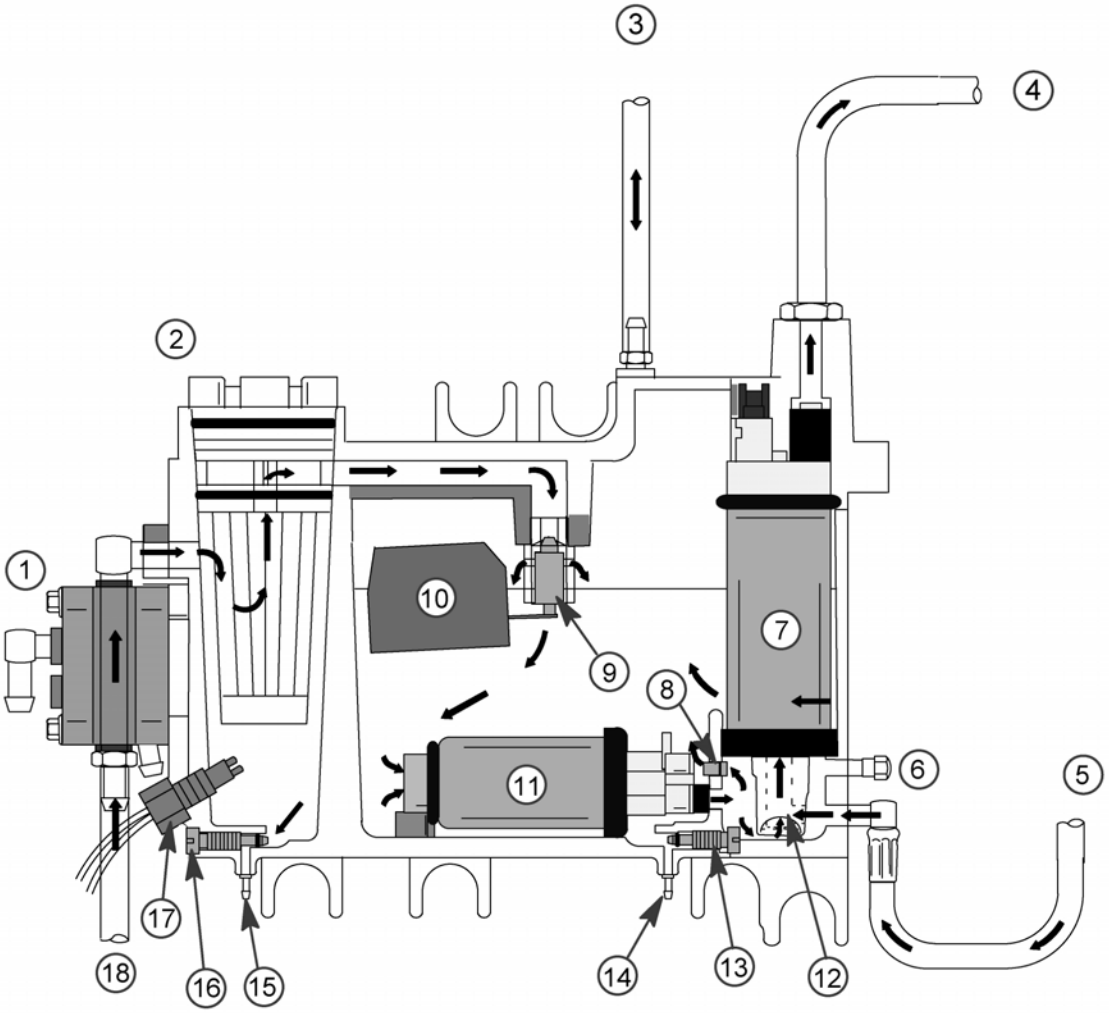
Easy to remove screw in water separating fuel filter, canister filter no longer used.

High pressure electric fuel pump enclosed inside the IVST.

Water sensor probe mounted at end of IVST for easy removal.

Water can easily be drained from IVST by rotating drain screws at either end of IVST.

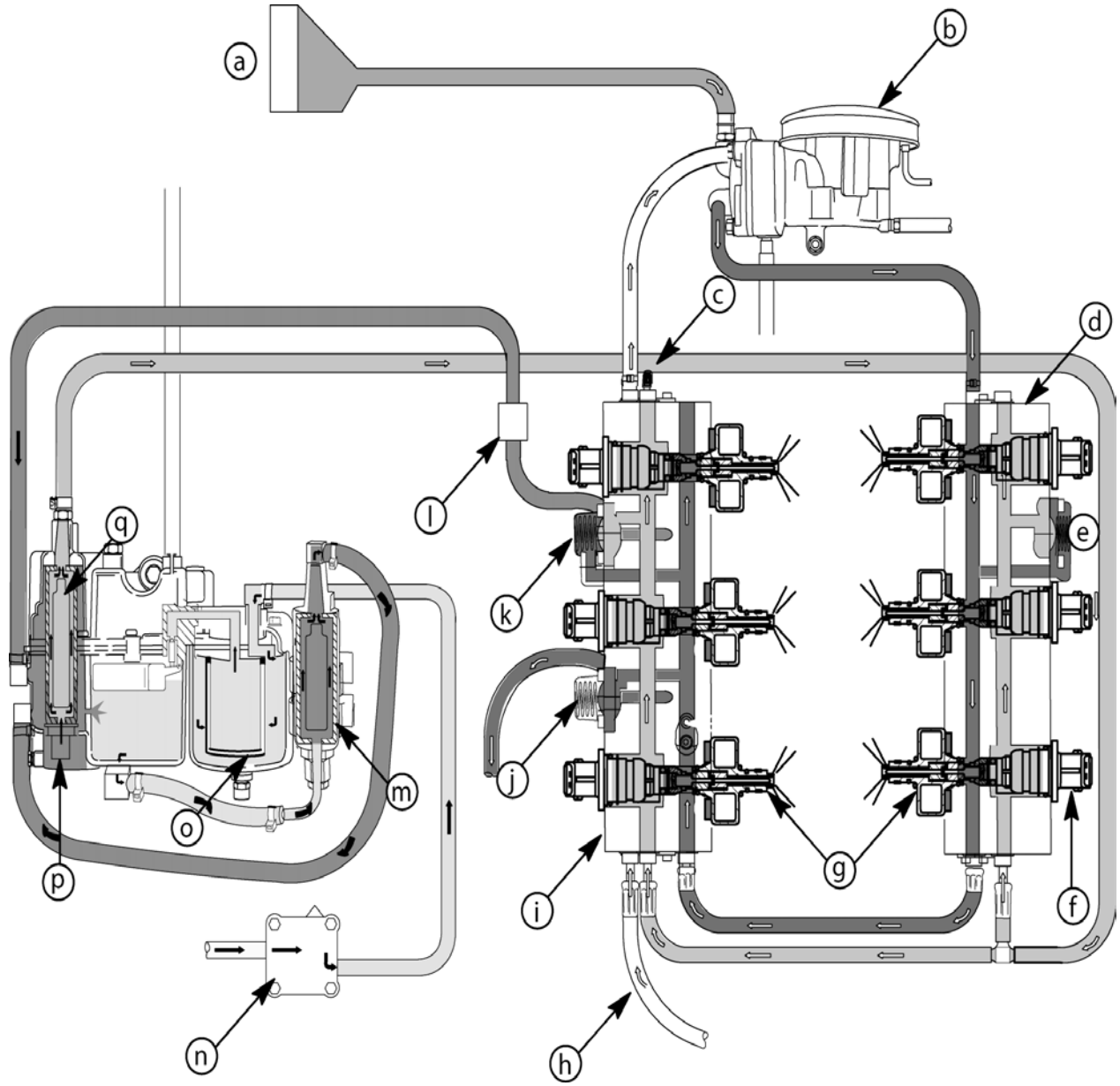
Low pressure electric fuel pump pressure can be checked directly off schrader valve mounted on IVST.



1. Engine pulse fuel pump
2. Fuel/Water separator filter
3. Vapor separator tank vent hose
4. Fuel outlet from high pressure electric fuel pump – 751.5 kPa (109 psi)
5. Bleed off from fuel pressure regulator; routed back to vapor separator tank.
6. Low pressure electric fuel pump Schrader valve
7. High pressure electric fuel pump
8. 172 kPa (25 psi) relief valve
9. Vapor separator tank float needle
10. Vapor separator tank float
11. Low pressure electric fuel pump
12. Fuel Director
13. Vapor separator tank drain screw
14. Vapor separator tank drain fitting
15. Fuel/Water Drain Fitting
16. Fuel/Water Drain Screw
17. Fuel/Water sensor
18. Fuel Inlet from primer bulb

Notes

2002 & Up 2.5L OptiMax Air/Fuel Schematic



a) Air Intake to Compressor
b) Air Compressor
c) Fuel System Test Valve
d) Starboard Fuel Rail
e) Tracker
f) Fuel Injector (6)
g) Direct Injector (into Combustion Chamber)
h) Water into Rail
i) Port Fuel Rail
j) Air Pressure Regulator
k) Fuel Pressure Regula tor
l) 40 psi Check Valve
m) Low Pressure Electric Fuel Pump
n) Mechanical Fuel Pump
o) Water Separating Fuel Filter
p) Fuel Filter
q) High Pressure Fuel Pump

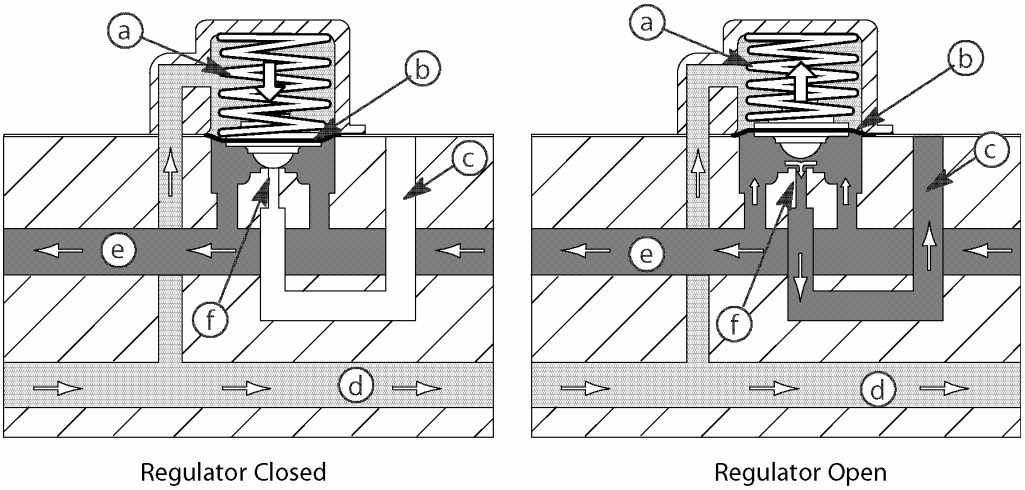
NOTE: Typical example, component location will vary on other models.

Notes

Fuel Pressure Regulator

- Calibrated to raise fuel pressure 10 psi above air pressure
- Uses both air & internal spring pressure to control fuel pressure
  - ♦ Internal spring calibrated at 10 pounds resistance
  - ♦ Spring holds the diaphragm against seat
  - ♦ Contact between diaphragm and seat closes the passage between incoming fuel (from the electric fuel pump) and the fuel return passage
- When the engine isn't running (no air pressure on spring side of diaphragm) the fuel pressure required to move the diaphragm is 10 psi
- When the engine is running, air pressure from the air compressor (80 psi) is routed to the spring side of the diaphragm
- The air pressure (80 psi) and the spring pressure (10 psi) combine to regulate the fuel system pressure to 90 psi…or 10 psi than the air pressure in the DFI system/fuel rails

Sectional View



Regulator Closed Regulator Open

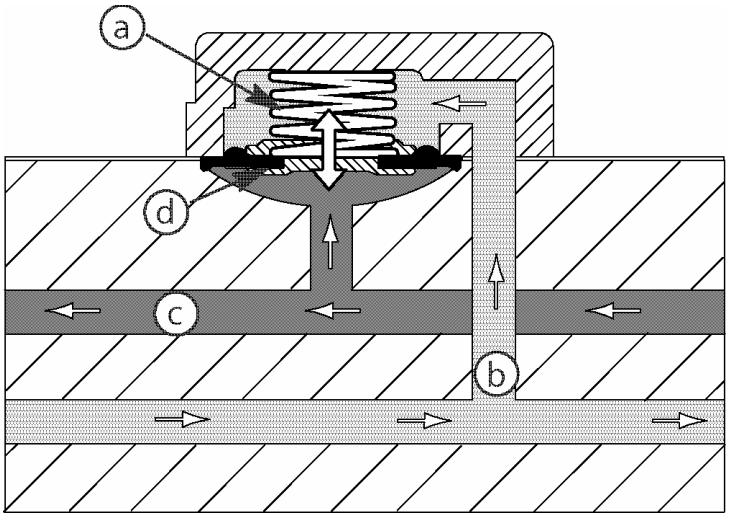
a – 10 lb. spring (15 lb. spring on 1.5L models)
b - Diaphragm
c - Fuel return line to VST
d - Air passage
e - Fuel passage
f - Excess fuel return opening

Tracker Valve (V6 Models Only)

Notes

- Tracker valve designed to maintain 10 psi differential between the fuel rails when air or fuel pressure suddenly rises (air compressor pulses or fuel injectors opening & closing)
- Contains a spring (on the 'air' side) & a diaphragm
- When engine isn't running, spring positions diaphragm against seat
- When the engine is running, fuel pressure compresses spring and diaphragm moves slightly away from seat, to a 'neutral' position
- Pressure on both sides of diaphragm is equal
- Note: to prevent excessive seat wear, the tracker valve is calibrated to allow the diaphragm to be slightly away from the seat during normal operation.
- Any air or fuel pressure 'spikes' on either side of the diaphragm will transfer this pressure increase to the other side of the diaphragm
- Both sides (air & fuel) will have a momentary increase in pressure so that the 10 psi difference can be maintained
- If pressure rises inside fuel passage, the diaphragm will flex into the air passage, causing a proportionate increase in air pressure
- If pressure rises in the air passage, the diaphragm flexes into the fuel passage, increasing the fuel pressure proportionately

SECTIONAL VIEW TRACKER VALVE

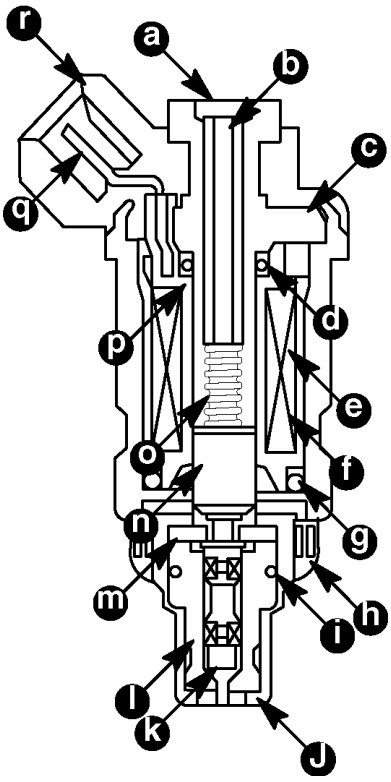


a - Spring
b - Air passage
c - Fuel passage
d - Diaphragm

Notes

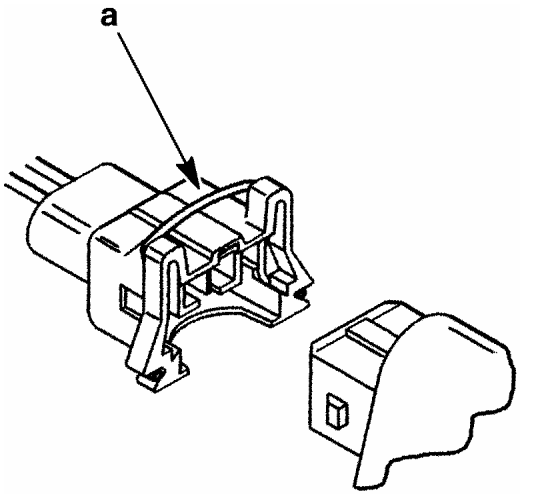
Fuel Injector

A fuel injector is an electromagnetic device. The precision mechanical components are controlled by means of the solenoid in the injector, the solenoid is energized by an injector driver in the ECM. The driver circuit controls the “on” time of the solenoid by providing a ground.



a) Top Cap
b) Inner Collar
c) Sleeve
d) O-Ring
e) Solenoid Coil
f) Tape
g) O-Ring
h) Filter
i) O-Ring
j) Cap
k) Needle Valve
l) Nozzle
m) Valve Stopper
n) Core
o) Bobbin
p) Spring
q) Connector
r) Terminal

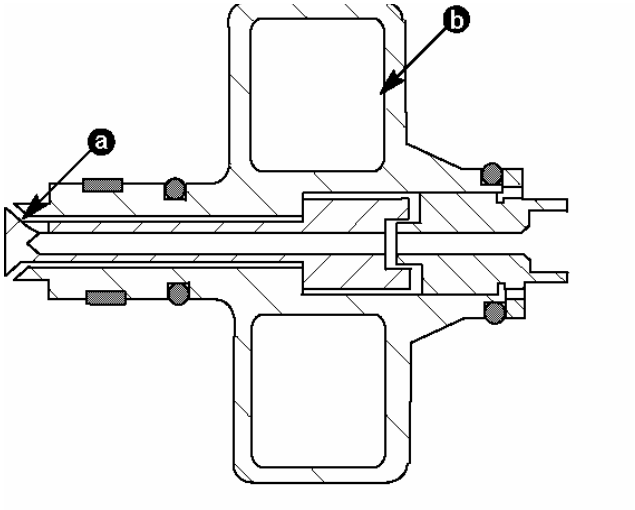
Disconnecting Harness Connectors from Ignition Coils and/or Injectors



a) Wire Clip (push center down to remove)

Direct Injector

The Direct injector uses a tapered tip and seat. The tapered tip is ground to provide a leakproof seal. The tapered tip is controlled by the ECM through the use of a solenoid inside the injector.

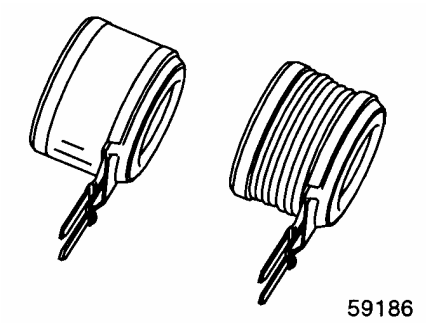


a) Tapered Tip
b) Solenoid Coil

Notes

DIRECT INJECTOR - 2002 MY RUNNING CHANGE

New direct injector with encapsulated coil winding. A hard plastic coating is placed around the winding prior to the molding process for the plastic housing. This prevents the outer windings of the coil from being pushed out of place and shorting to the metal housing as the plastic molding material is injected into the mold. This product improvement should reduce or eliminate shorted windings. When this change occurs the blue dot injector housing will be molded out of blue plastic.



NOTE: The color of direct injectors have changed over time as follows:

- All BLACK Injectors supersede to BLUE Injectors.
- The GRAY Injectors are used on 3 Cylinder models and All High Performance models.

Direct Injector Shorted to Ground

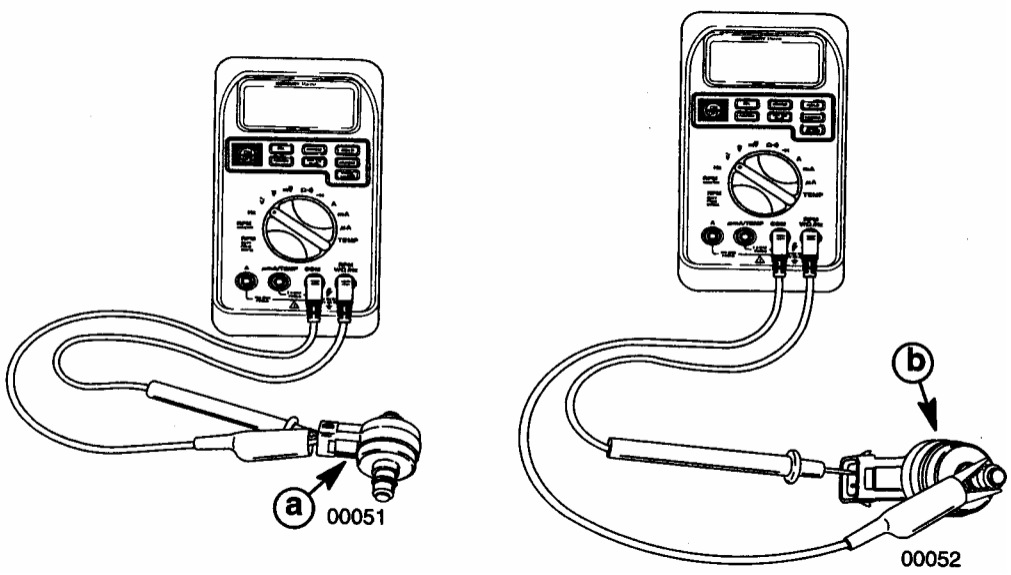
Models: All OptiMax Product, 1998 and Newer

Situation: Current service literature indicates that there should be no continuity between the direct injector connector pins and engine ground. Engineering has determined that direct injectors that have an ohms reading from each connector pin to ground greater then 700 ohms will operate correctly and does not need to be replaced

NOTE: For best results check the direct injector for continuity to ground when the injector is near operating temperature (engine warmed up).

To allow for meter and/or temperature variations, a reading of 1000 ohms has been set as the determining point to replace or not replace the direct injector.

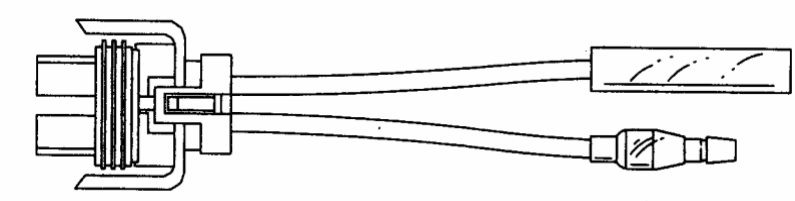
- Meter reading greater then 1000 ohms, the injector performance will not be affected and does not need to be replaced
- Meter reading less then 1000 ohms, the performance could be affected and the injector should be replaced



a – Direct injector ohm test between the two connector pins (1.0 – 1.6 ohms)
b – Check between each connector pin and the metal portion of the injector, ohms reading should be 1000 ohms or greater.

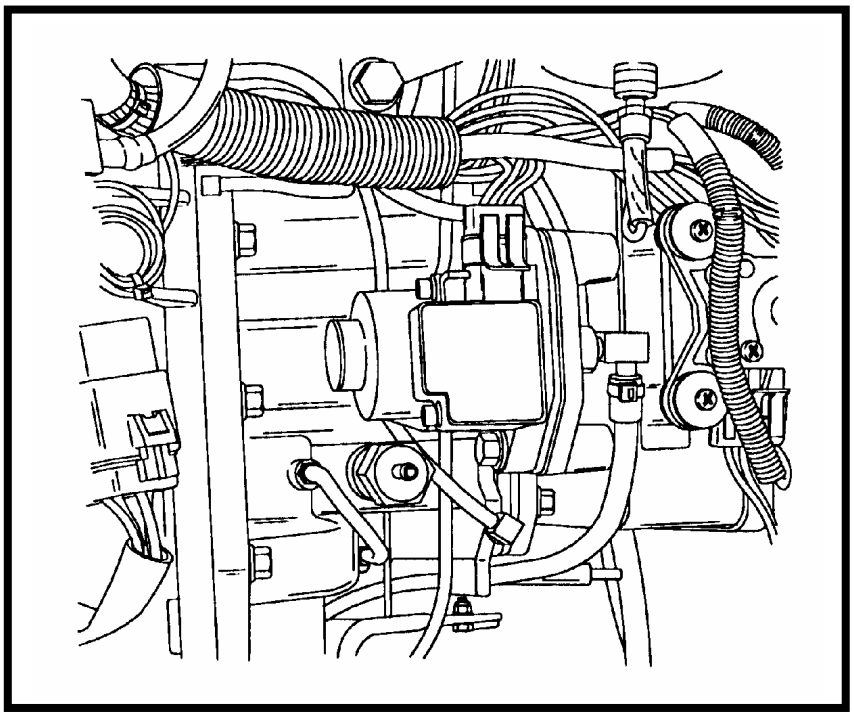
NOTE: Making resistance checks on a direct injector while still installed in the engine can be difficult. An easy and fast way to make resistance (ohms value) checks on direct injectors is to use service harness 84-858781A2, shown below. This harness is normally used as a service replacement part for the direct injector connector if it becomes damaged, but also works well to make the required resistance and ground test while the injector is in place between the cylinder head and fuel rail.

Service literature will be updated with this information as manuals are revised



Notes

Section 5 - Oil Injection System



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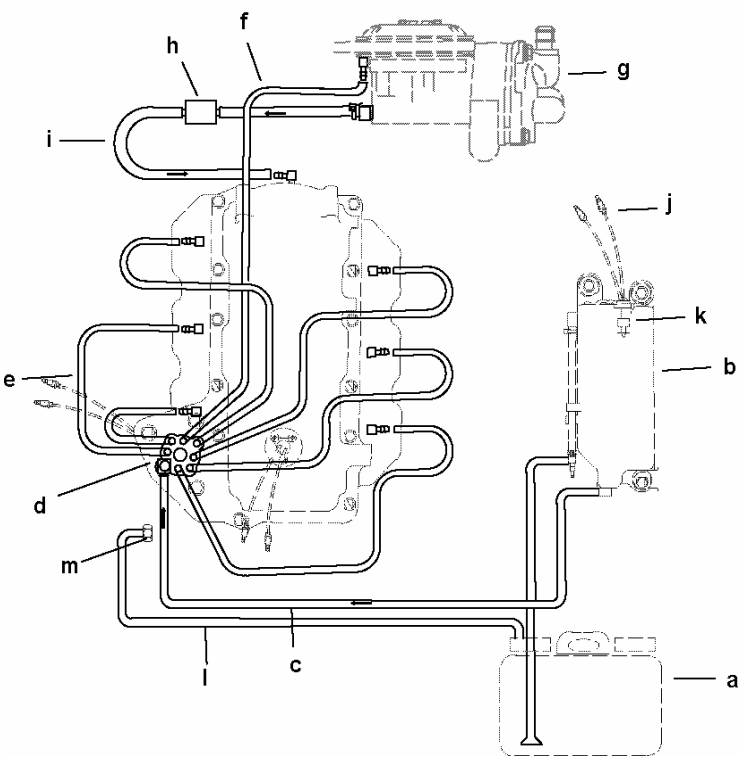
Notes

Oil System Operation

Oil in this engine is not mixed with the fuel before entering the combustion chamber. Oil is stored inside the remote oil tank in the boat. Crankcase pressure forces oil from the remote oil tank into the engine oil tank. The engine oil tank feeds oil to the oil pump. The oil pump has seven oil discharge ports. Six of the oil discharge ports inject oil into the crankcase through hoses, one for each cylinder. The last oil discharge port discharges oil into the air compressor for lubrication. Unused oil from the air compressor returns to the plenum and is ingested through the crankcase.

The ECM is programmed to automatically increase the oil supply to the engine during the initial break-in period. During the initial engine break-in period, the oil ratio is doubled during the first 120 minutes of operation over 2500 RPM. Oil ratio below 2500 RPM is at the normal rate. After the engine break–in period, the oil ratio will return to normal – 300 - 400:1 at idle to maximum of 60:1 at WOT (depending upon engine load).

1998/1999 2.5L Oil System

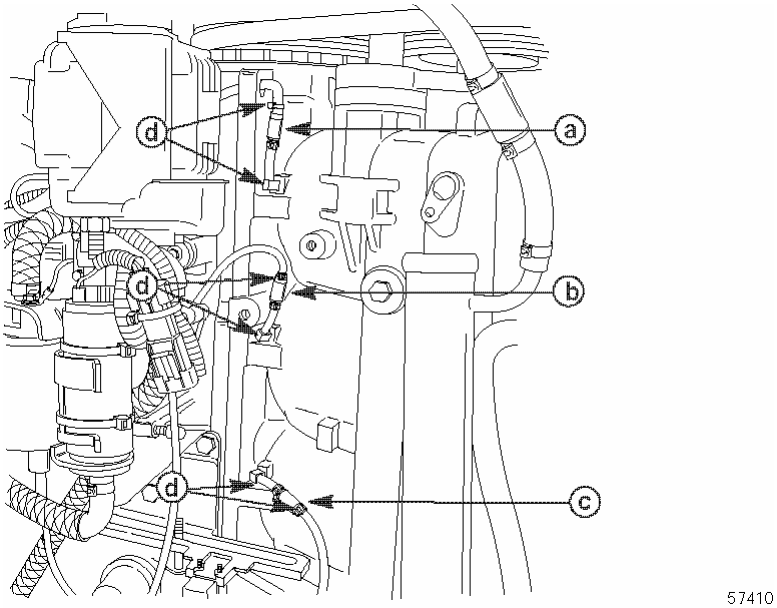


a) Remote Oil Tank
b) Engine Oil Tank
c) Oil Supply Hose to the Oil Pump
d) Oil Pump
e) Oil Supply Hoses to the Cylinders
f) Oil Supply Hose to the Air Compressor
g) Air Compressor
h) Check Valve
i) Oil Return Hose from the Air Compressor
j) Low Oil Sender Wires (to ECM)
k) Magnetic Float
l) Air Pressure
m) Crankcase Pressure w/One Way Check Valve

Check Valve Kit – 1998/1999 135/150 OptiMax

Notes

Check valves have been to the crankcase oil delivery hoses to prevent evacuation of oil from the hoses under certain running conditions and to improve oil delivery to the engine. This product improvement is being offered to current owners and on outboards in dealer inventory to provide improved reliability and durability. The check valves have been installed on production outboards as a running change beginning with serial number 0G886267. Check valves used in production will be incorporated into the oil hose fitting pressed in the cylinder block and not an inline check valve.



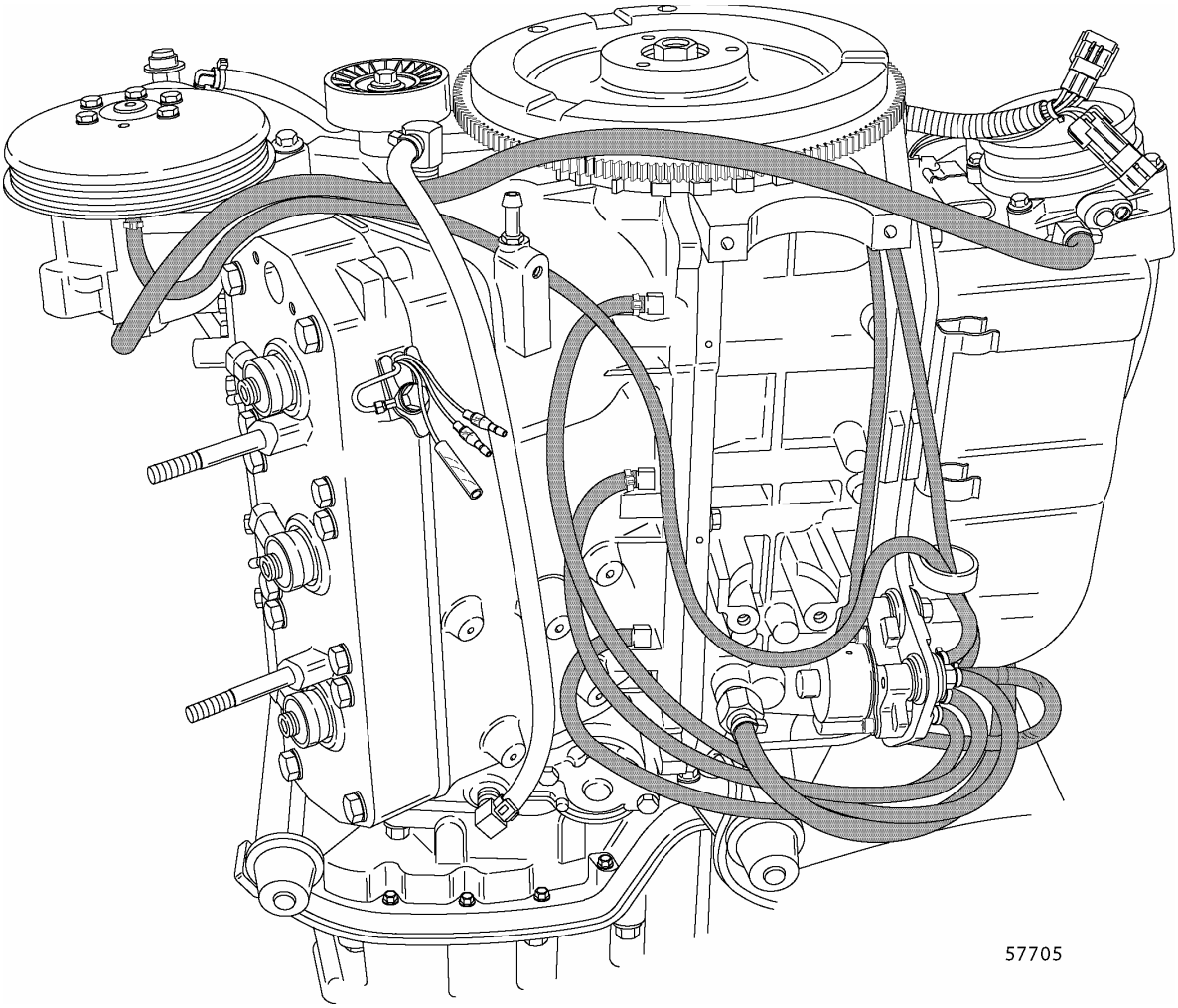
57410

Check Valve Location – Port Side (Starboard Side Similar)

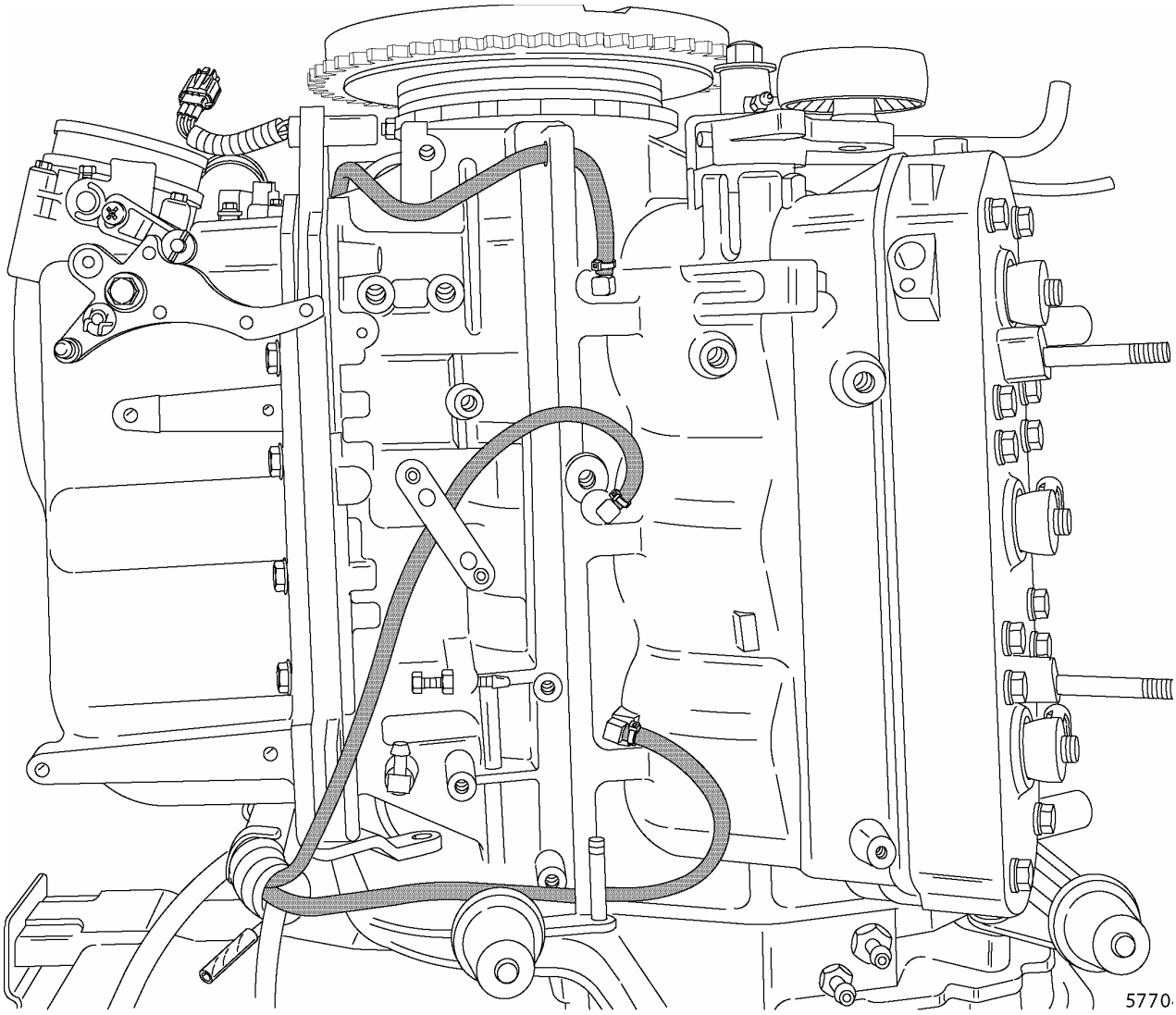
a) #2 Cylinder Oil Hose (Trim hose length as required)
b) #4 Check Valve/Hose Assembly
c) #6 Check Valve/Hose Assembly
d) Sta-Straps

Tip: If powerhead is replaced, check valves are in block fittings. Check valves in oil lines must be removed.

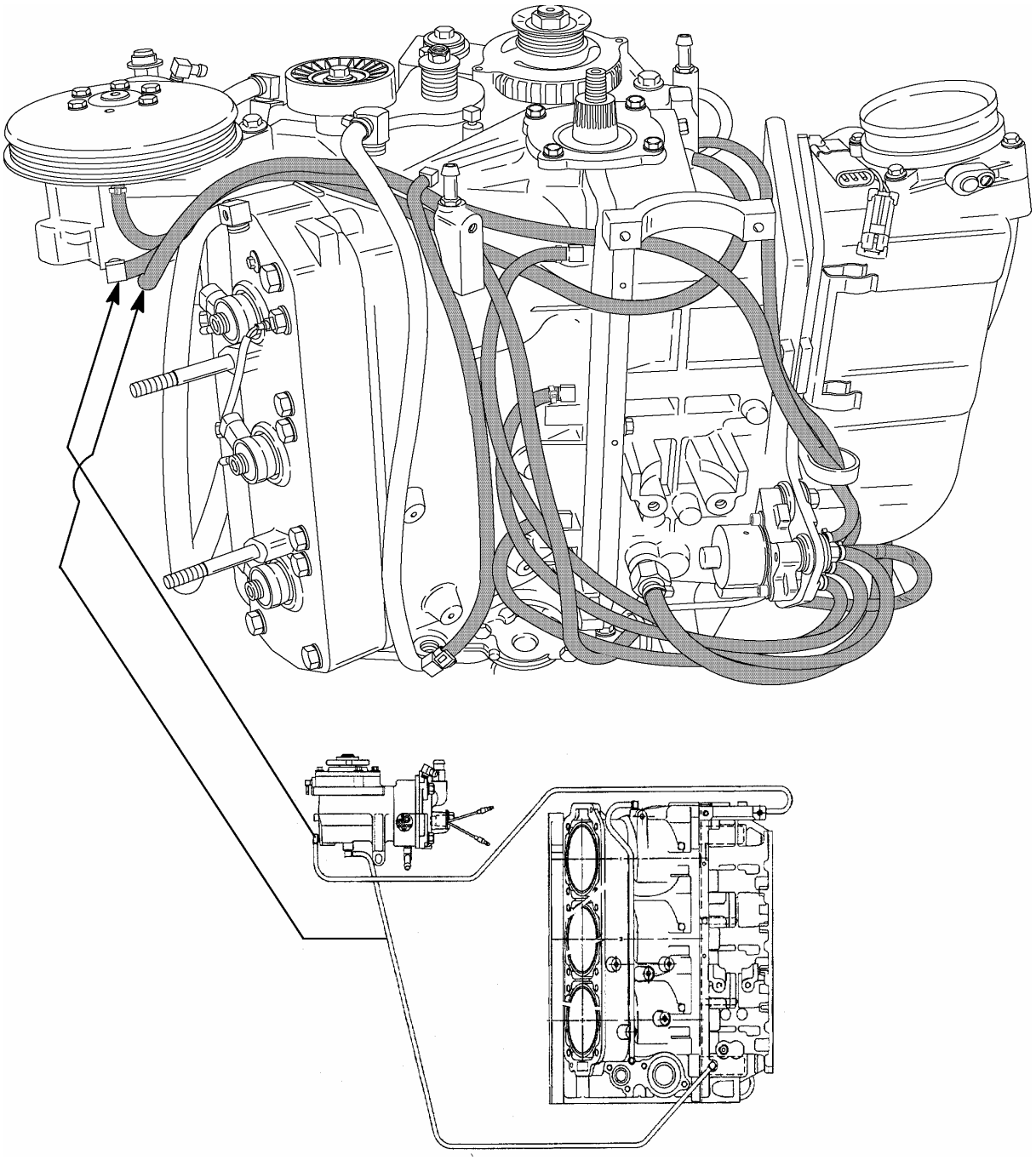
2.5L - Model Year 2000 Starboard Side Oil Hose Routing



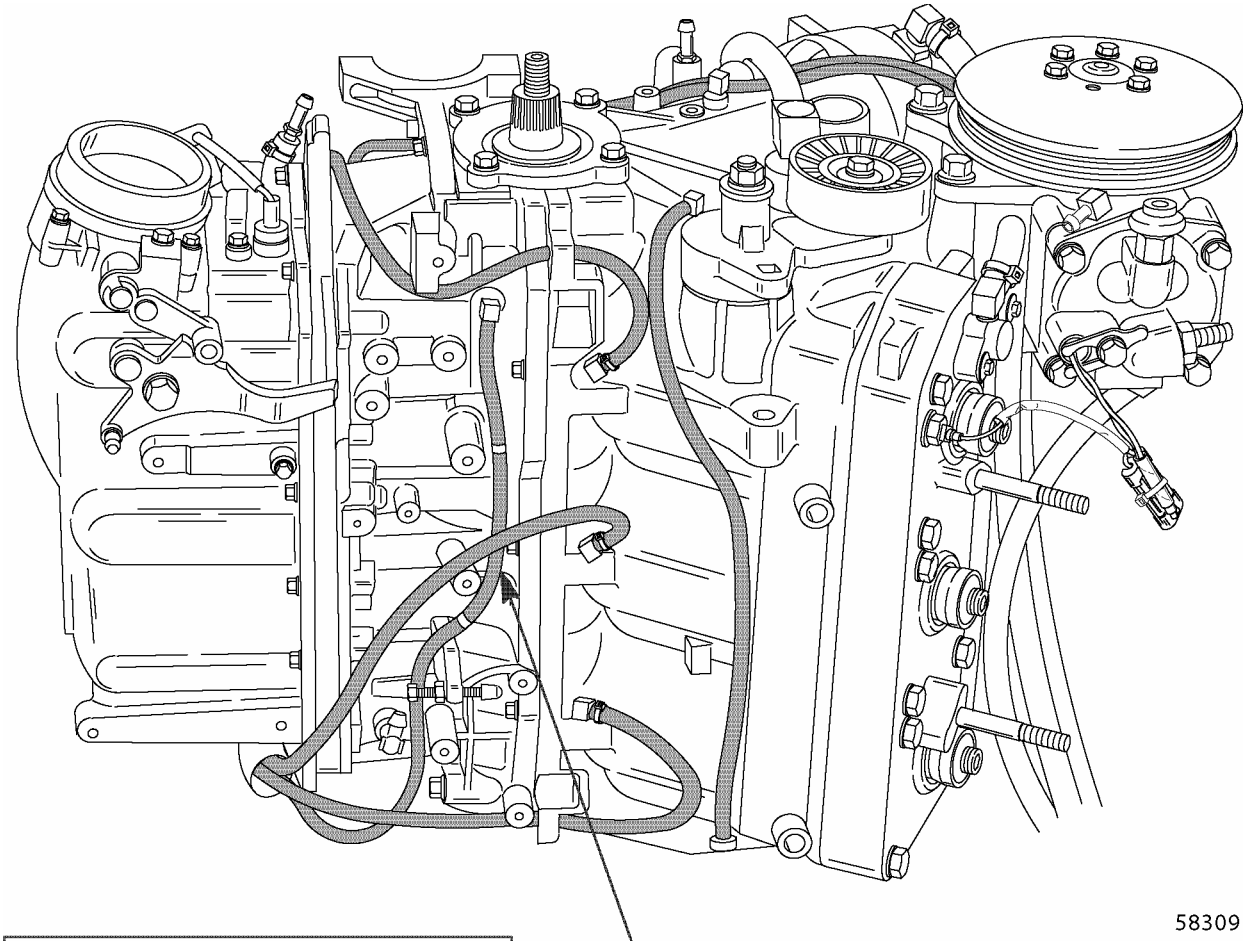
2.5L - Model Year 2000 Port Side Oil Hose Routing



2.5L - Model Year 2001 Starboard Side Oil Hose Routing



2.5L - Model Year 2001 Port Side Oil Hose Routing



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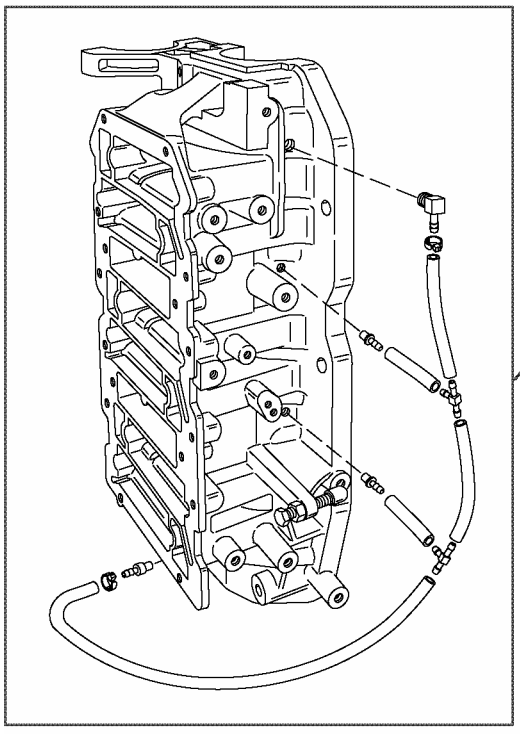

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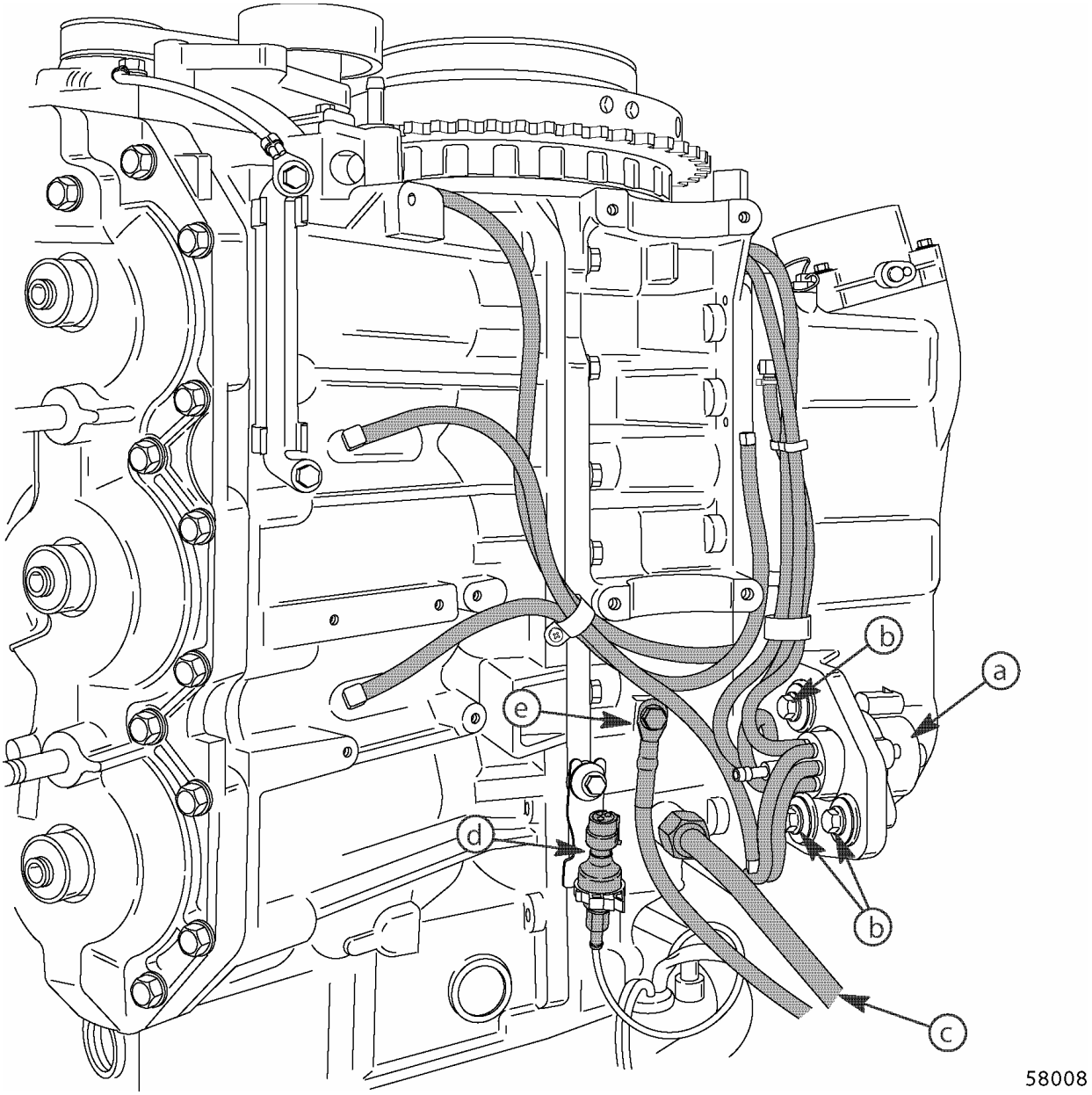
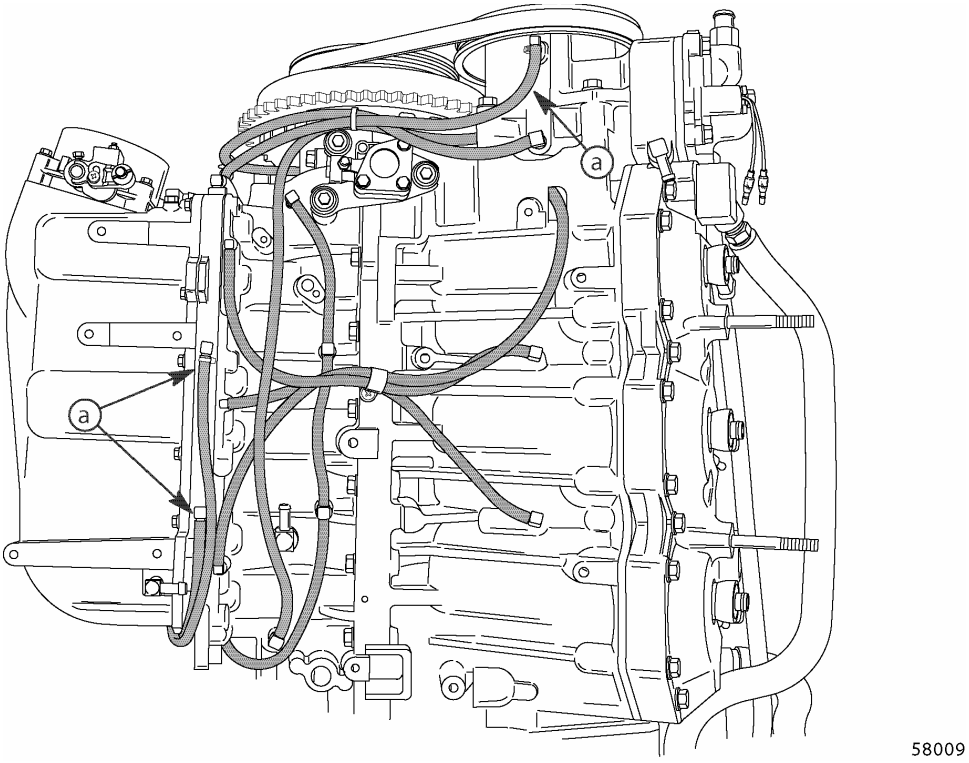
3.0L - Model Year 2000 thru 2002 Starboard Side Oil Hose Routing

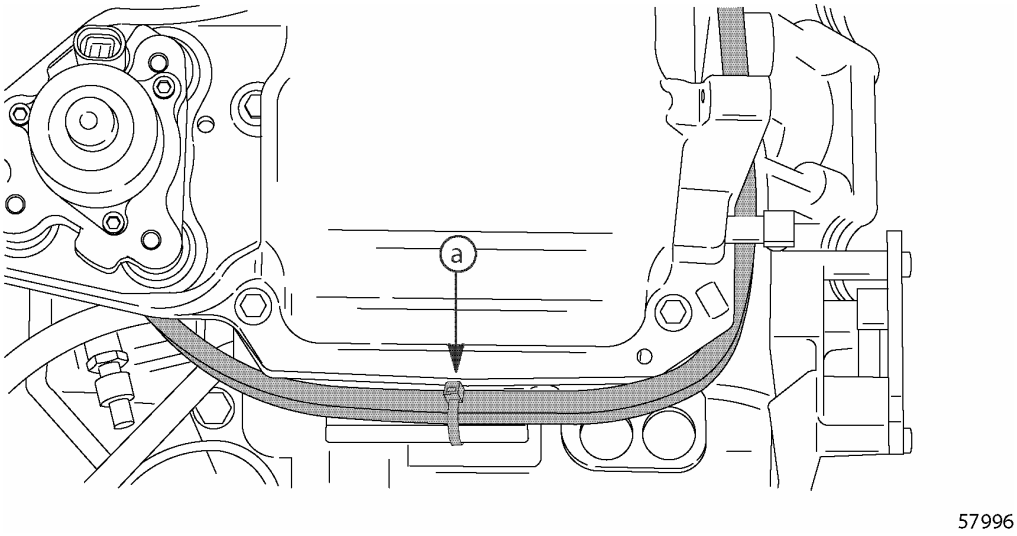


a - Oil Pump
b - Bolts (3)
c - Remote oil tank pressure hose
d - SmartCraft speedometer gauge pressure sensor
e - Negative battery cable

3.0L - Model Year 2000 thru 2002 Port Side Oil Hose Routing

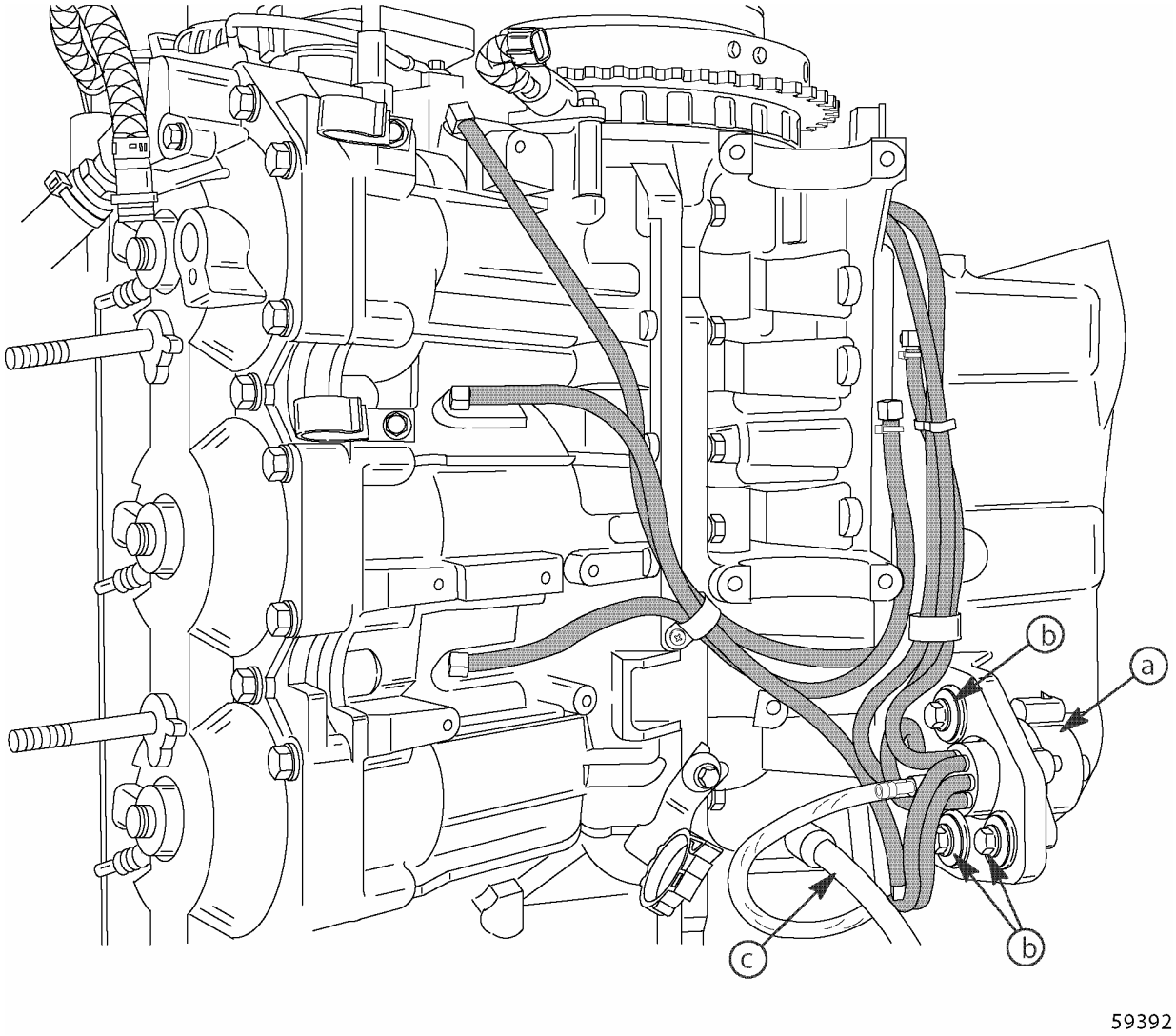


a - Oil pump hoses



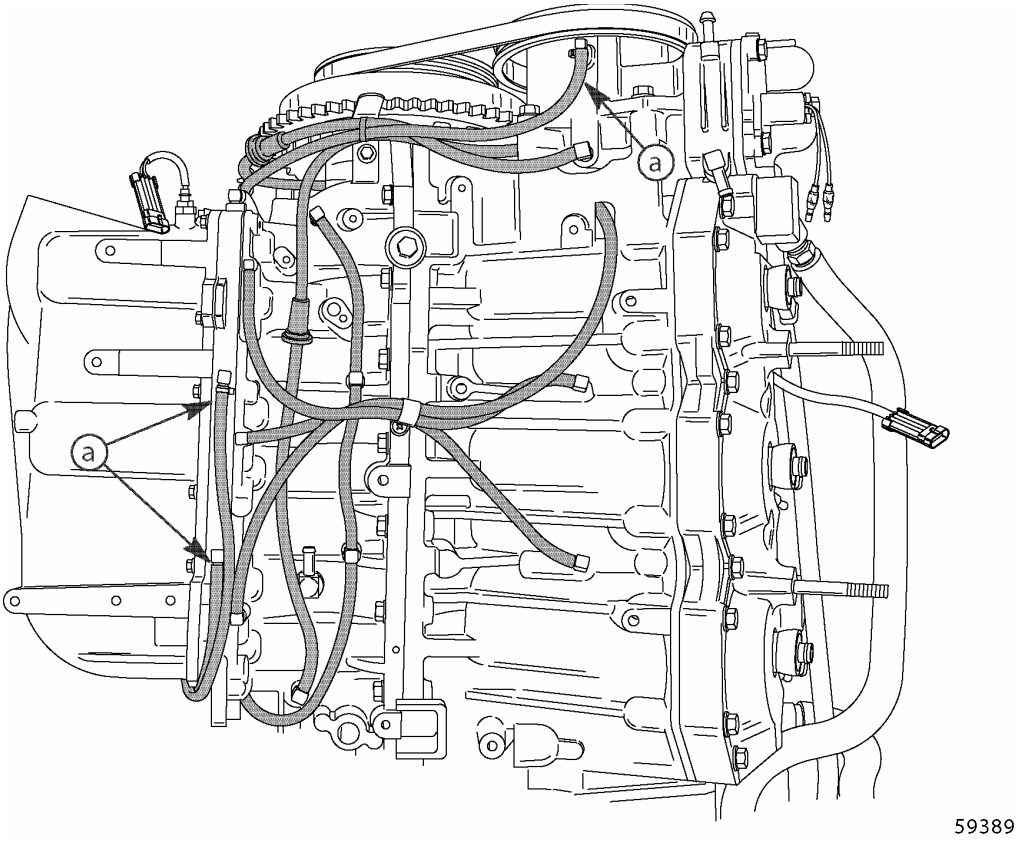
a - Oil hoses from oil pump routed under air plenum and secured by sta-strap

3.0L - Model Year 2003 Starboard Side Oil Hose Routing

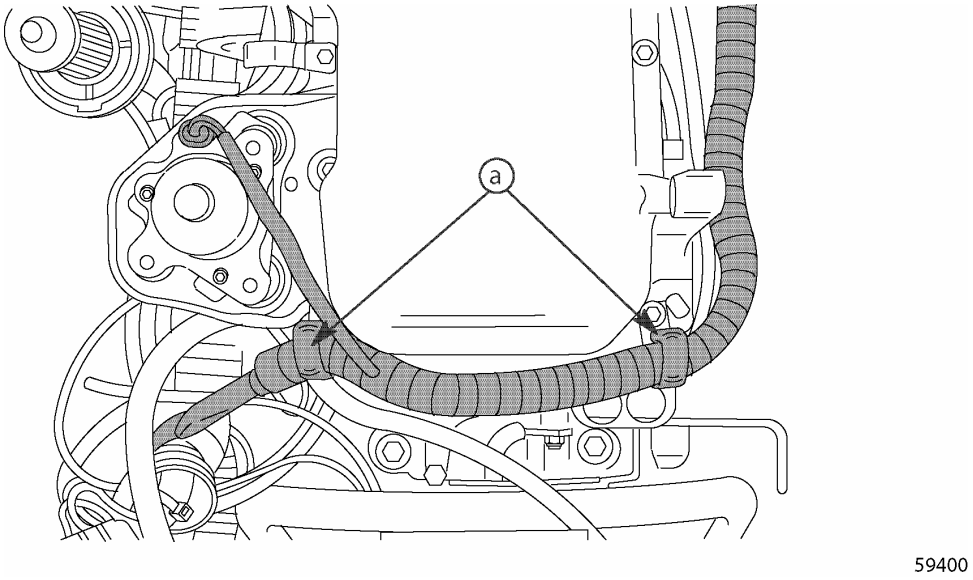


a - Oil pump
b - Bolts (3)
c - Remote oil tank pressure hose

3.0L - Model Year 2003 Port Side Oil Hose Routing

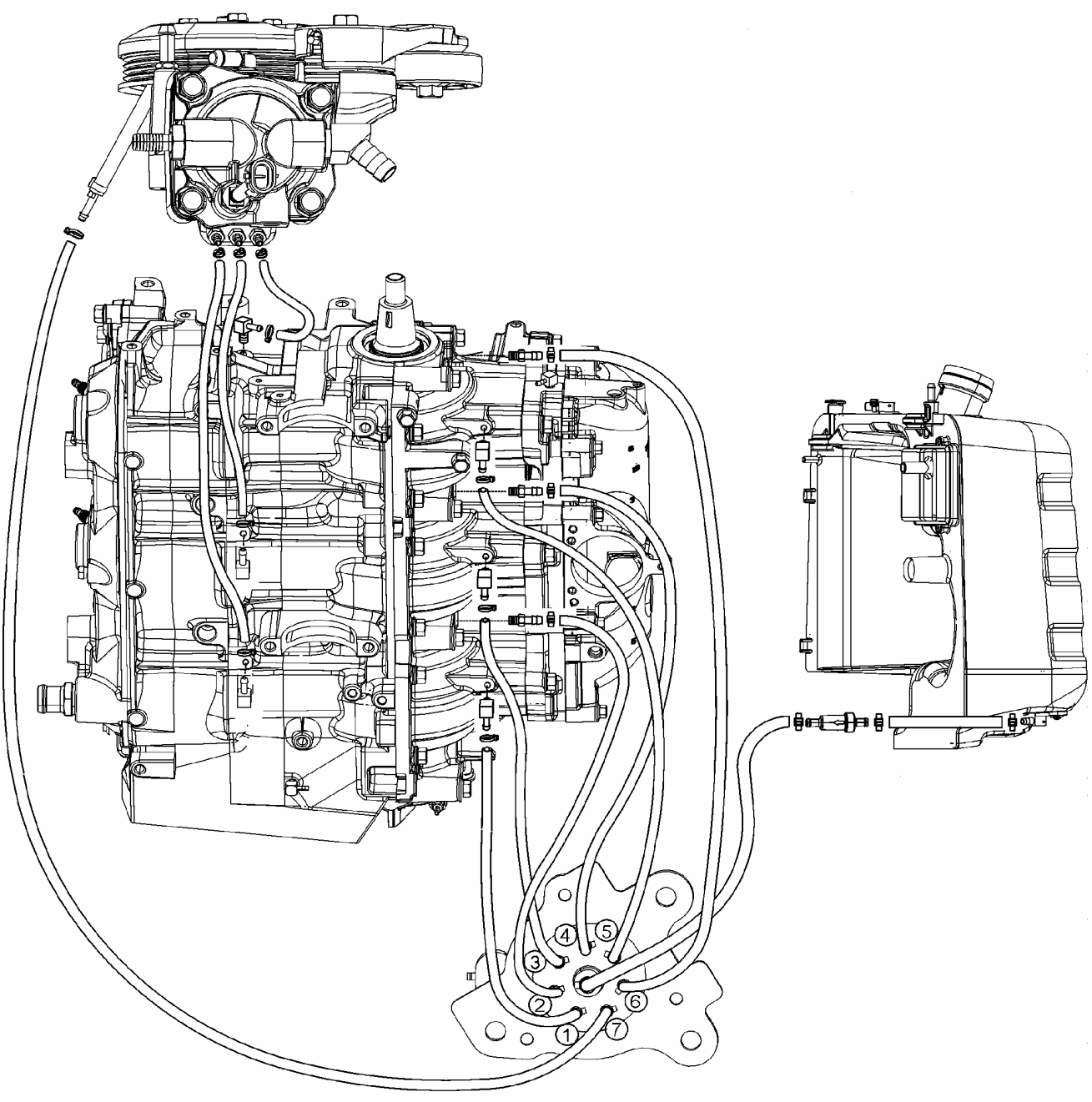


a - Oil pump hoses



a - Oil hoses and harness from oil pump routed under air plenum and secured by j-clamps.

1.5L – Model Year 2004 Starboard Side Oil Hose Routing



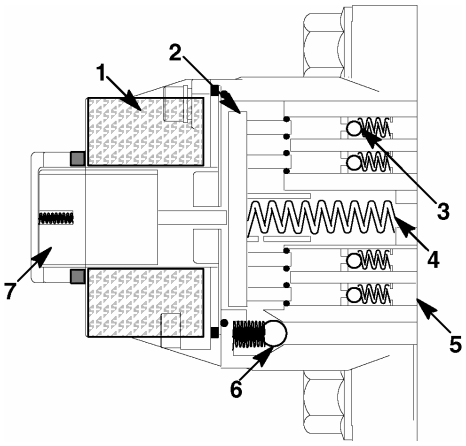
New 1.5L Models - Oiling System Highlights

- Engine mounted oil reservoir is standard.
- Engine reservoir filled without removing top cowl.
- Low oil sensor mounted at bottom of engine reservoir, normally closed switch.
- Oil level in engine reservoir checked with gauge (chain) connected to fill cap.
- Remote 3 gallon oil tank optional P/N 1257-8742A25
- Oil filter between engine reservoir and oil pump (replace every 100 hours).
- Same 7 outlet port oil pump as V6 OptiMax, (3 to crankpin area, 3 to transfer port area, and 1 to air compressor).
- Oil usage is about 40 % of what the current 3.0 Liter OptiMax uses.
- Oil ratio is 300-400 : 1 at idle, 50:1 at WOT
- Return oil from air compressor is directed to cylinder bores.

Notes

Notes

OptiMax Oil Pump

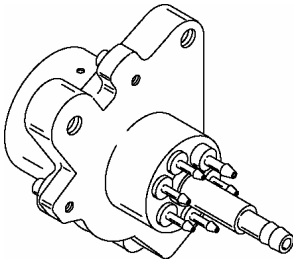


1) Coil
2) Piston Assembly
3) Outlet Check Valve
4) Return Spring
5) Oil Discharge Port (4 Shown)
6) Inlet Check Valve
7) Plunger

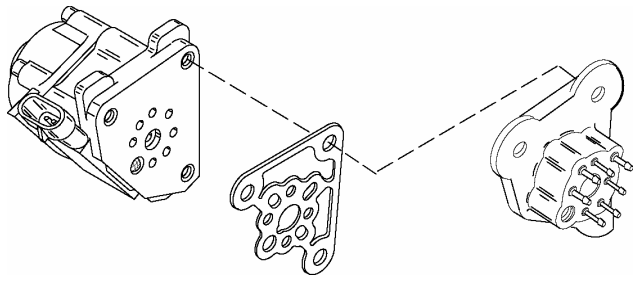
OptiMax Oil Pump Change

NOTE: Older pump supersedes to newer pump for service. Refer to Service Bulletin 2003-8 (New P/N 2.5L is 859372A01 and 3.0L is 859373A01).

NEWER

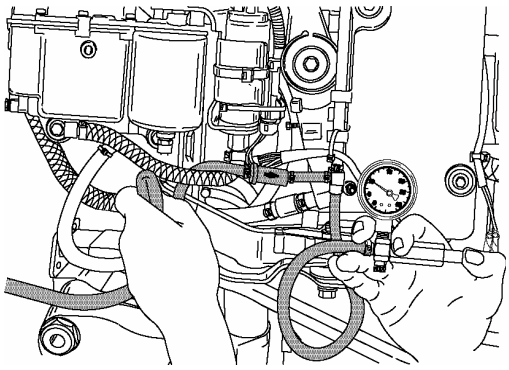


OLDER



Priming the Oil Pump

NOTE: *If a new powerhead is being installed or oil hoses/oil pump has been removed, it is recommended all air be purged from oil pump/oil lines. This can be accomplished by using a gearcase leakage tester(FT-8950). Connect the leakage tester to the inlet t-fitting on the onboard oil reservoir. While clamping off the inlet hose, manually pressurize the reservoir to 10 psi. Using the Digital Diagnostic Terminal 91-823686A2, activate the oil pump prime sequence. Maintain the 10 psi pressure throughout the auto prime sequence. When the auto prime is completed, remove the leakage tester and refill the onboard oil reservoir.*



Priming the oil pump (filling pump and hoses) is required on new or rebuilt engines and any time maintenance is performed on the oiling system.

There are three methods for priming the oil pump:

METHOD 1 - SHIFT SWITCH ACTIVATION PRIME

This method does three things:

a) Fills the oil pump, oil supply hose feeding pump and oil hoses going to the crankcase and air compressor.
b) Activates break-in oil ratio.
c) Initiates a new 120 minute engine break-in cycle.

Refer to priming procedure following.

METHOD 2 - (DDT) DIGITAL DIAGNOSTIC TERMINAL – RESET BREAK-IN

This method is the same as Method 1, except the run history and fault history are erased from the ECM.

Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge.

Notes

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METHOD 3 - (DDT) DIGITAL DIAGNOSTIC TERMINAL - OIL PUMP PRIME

This method fills the oil pump, oil supply hose feeding pump, and oil hoses going to the crankcase and air compressor.

Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge.

Conditions Requiring Priming the Oil Pump	
Condition	Priming Procedure
New engine	Use Method 1 or 2
Rebuilt Powerhead	Use Method 1 or 2
New Powerhead	Use Method 1 or 2
Oil system ran out of oil	Use Method 3
Oil drained from oil supply hose feeding pump	Use Method 3
Oil pump removed	Use Method 3
Oil injedtion hoses drained	Use Method 3

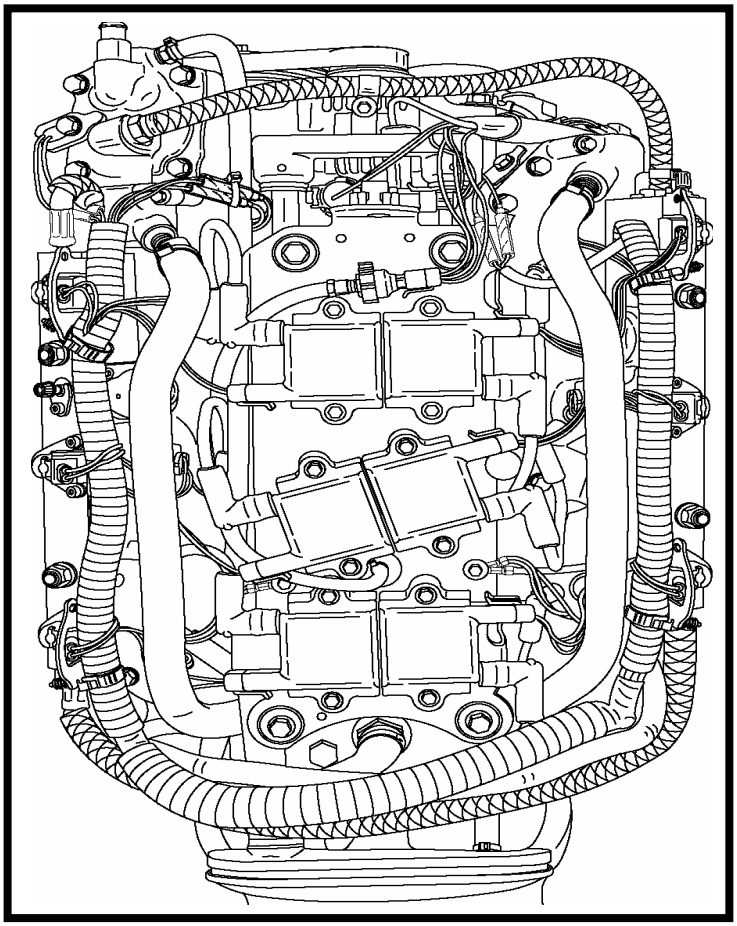
HIGH OIL CONSUMPTION

There have been reports of high oil consumption on both 2.5 & 3.0 Litre OptiMax. A high fuel to oil ratio may be normal for some light boat applications. When the engine is run between 4000-5000 RPM, the oil to fuel ratio can appear very rich on oil, even after the oil break-in has been completed. The reason for this is because the fuel consumption is lower due to the Opti-Max design, and the light boat application, but approximately the same amount of oil is required to lubricate the engine.

Example: An older EFI engine might use 1 gallon of oil and 50 gallons of fuel, at 5000 RPM traveling to and from an offshore fishing location, resulting in a 50:1 ratio. An OptiMax/DFI may use 1 gallon of oil and 28 gallons of fuel at 5000 RPM, to and from the same location, resulting in a 28:1 ratio. The overall oil consumption of an OptiMax/DFI product will be about the same as (EFI & Carb) product, if you compare oil consumption to running time and fuel to oil ratio. Higher than normal oil consumption can still occur, if you get a complaint of high oil consumption, use the following steps as a guide line.

- Use the DDT to confirm that the engine has completed the break-in procedure. (120 min. 2.5L & 240 min. 3.0L).
- Confirm how the oil consumption is being measured, and that the above light boat application does not apply.
- Confirm that the oil tank is NOT retaining pressure on shut down.
- If high oil consumption has been confirmed, it is likely that a check valve in the oil pump is stuck open. To confirm this, remove the oil pump from the manifold and remove the oil pump supply hose from the engine oil reservoir. Using a lower unit pressure checker, apply about 3 psi of pressure to the oil supply hose. If a continuous flow of oil is exiting an oil pump, replace the pump.

Section 6 - Electrical System



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Ignition System - V6 Models

Theory of Operation

When the ignition key is turned to the RUN position, battery voltage is applied to the main relay through the PURPLE wire. The main relay is then closed and D.C. current from the battery or charging system is transferred through the main relay 20 Amp fuse to the positive terminal of all 6 ignition coil primary windings. The negative terminal of the coil primary is connected to engine ground through the Electronic Control Module (ECM). When this circuit is closed, a magnetic field is allowed to be built up in the ignition coil. The Crank Position Sensor senses the location of the teeth on the flywheel and supplies a trigger signal to the ECM. When the ECM receives this signal, the ECM will then open the ground circuit of the coil primary. The magnetic field in the ignition coil primary will then collapse cutting across the coil secondary winding creating a high voltage charge (50,000 volts) that is sent to the spark plug.

Coil Driver

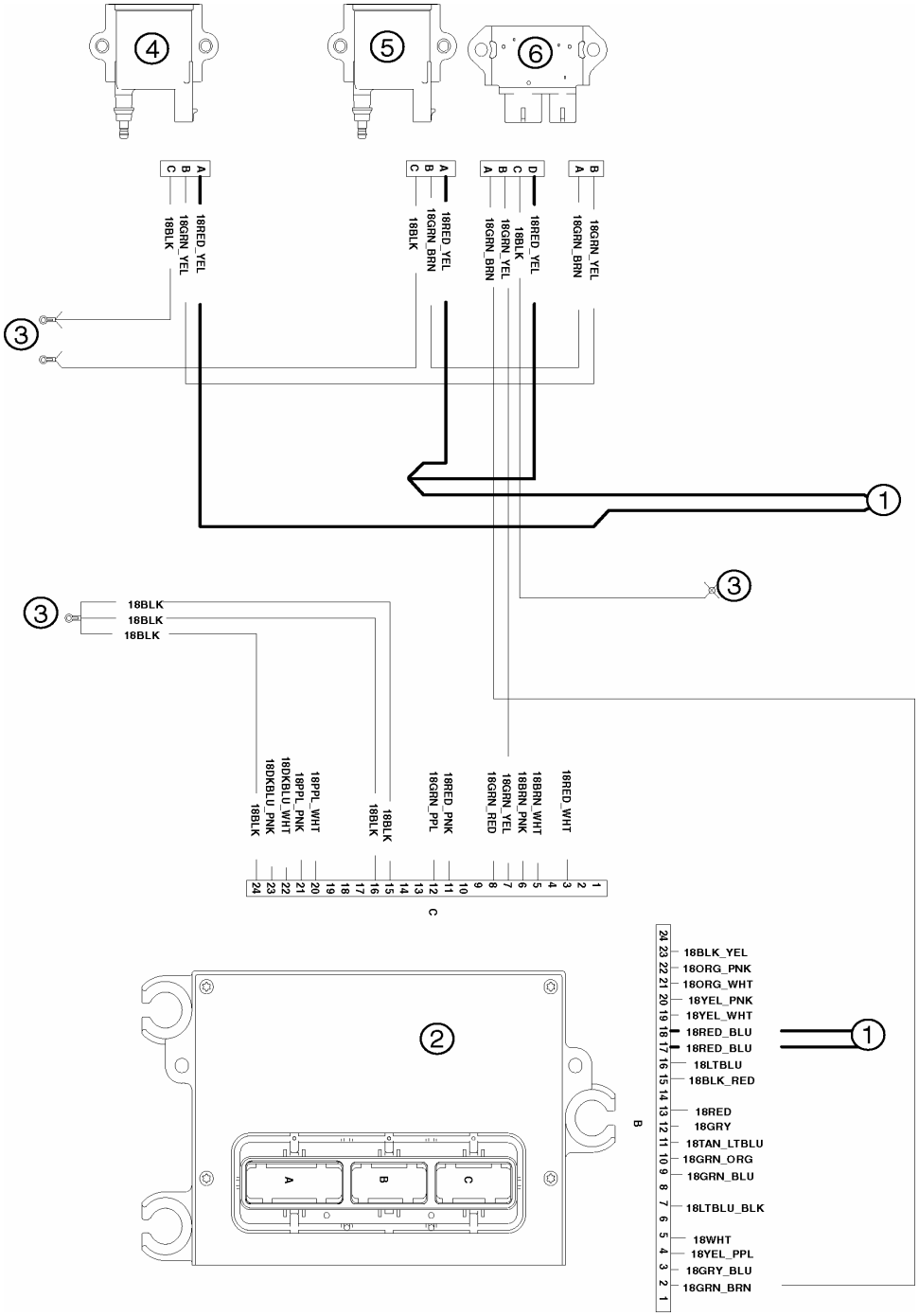
Model Year 2001 and Up

The ECM sends a 5 VDC pulse to the coil driver mounted on each ignition coil. Which coil driver receives this pulse is determined by the ECM receiving a signal from the crank position sensor.

When the coil driver receives its ECM pulse (signal), it closes its circuit which allows the primary side of the ignition coil to build up energy which it initially receives from the boat battery.

When the ECM pulse (signal) to the coil driver drops below 1.3 volts, the coil driver opens its circuit which causes the primary field of the ignition coil to collapse. This field collapse induces a voltage buildup in the secondary winding of the ignition coil resulting in a potential voltage of up to 50,000 volts at the spark plug.

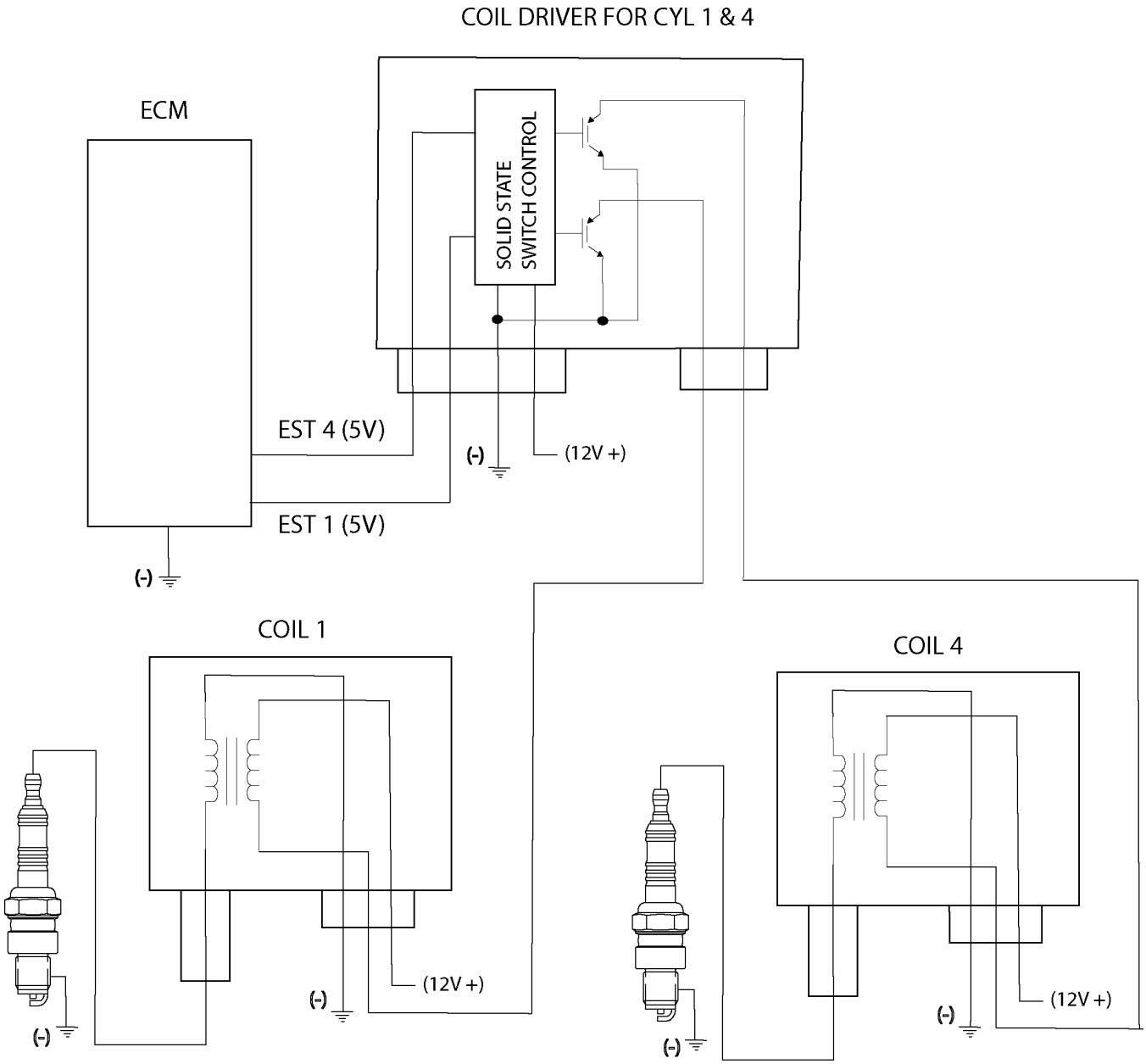
Ignition Coil Driver Operation

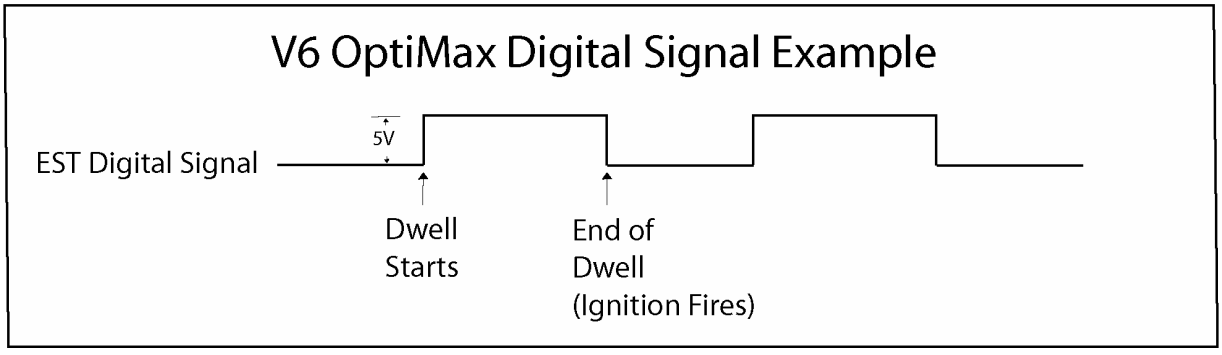


1) 12 Volt Power From Fuse
2) ECM
3) Ground
4) Ignition Coil #4
5) Ignition Coil #1
6) Coil Driver #1 & #4

Notes

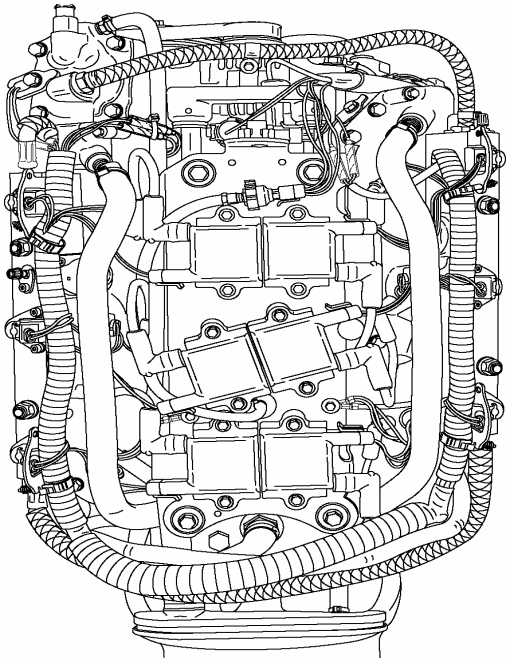
Ignition Coil and Driver Schematic



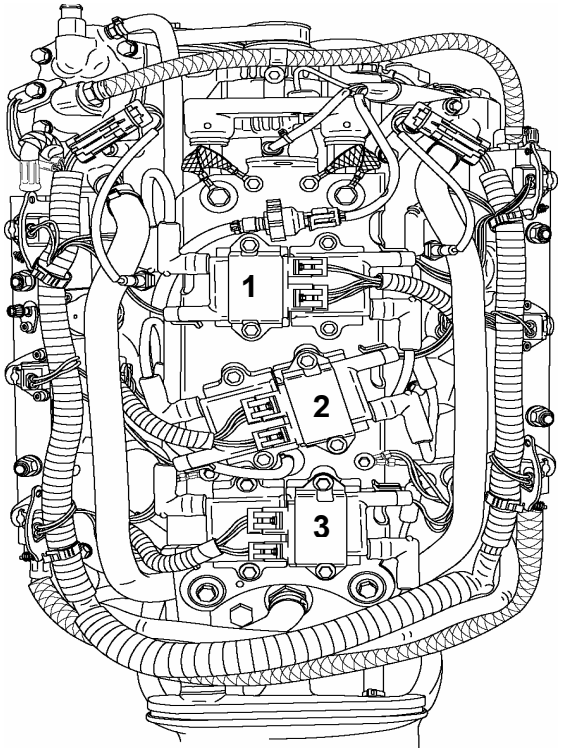


Ignition Coils

MODEL YEAR 2000



MODEL YEAR 2001 AND UP



1 – Cyl. 1 & 4
2 – Cyl. 2 & 5
3 – Cyl. 3 & 6

Notes

Notes

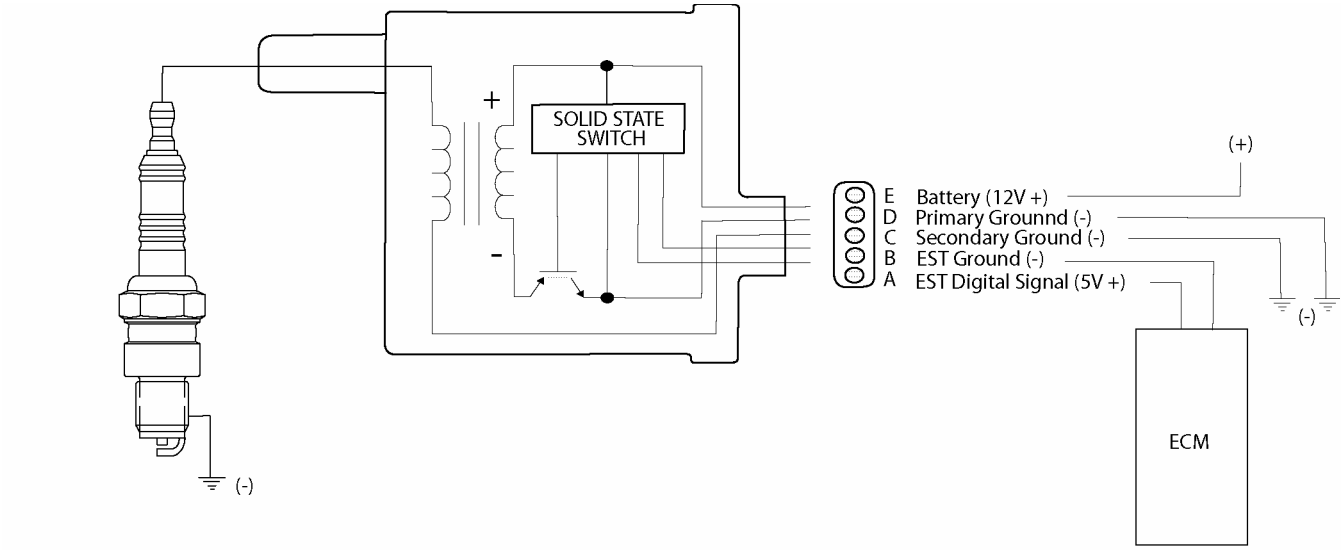
Ignition System - 3 Cylinder 1.5L Models

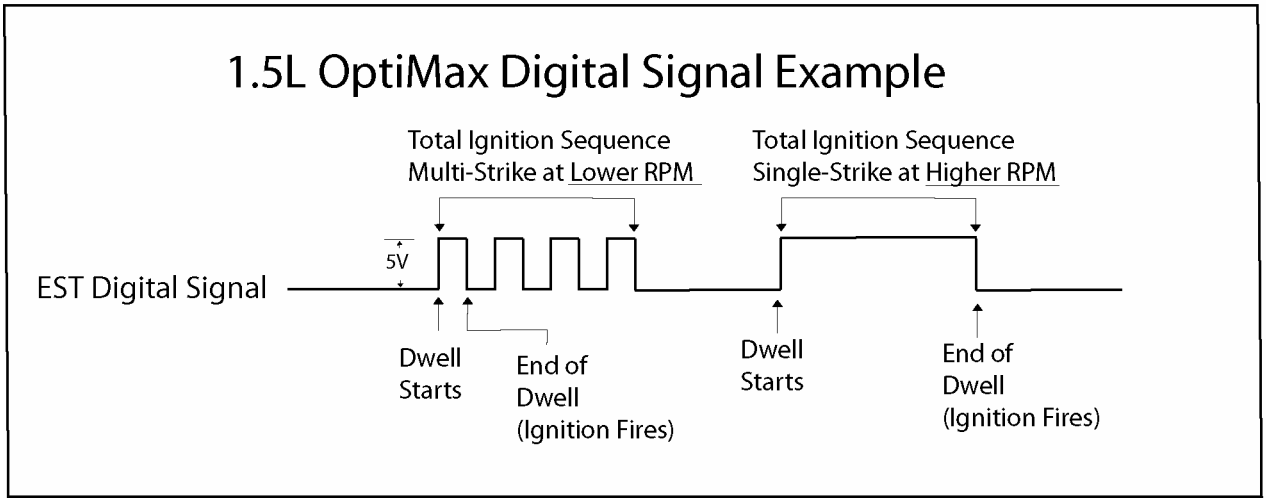
Theory of Operation

When the ignition key is turned to the RUN position, battery voltage is applied to the electrical system through the main power relay. If the Propulsion Control Module (PCM) does not sense engine rotation from the starter motor within a certain time period, the relay is turned off. Engine rotation will again engage the relay. When the main power relay is closed, system voltage is supplied through the dedicated 20 ampere ignition fuse to the positive terminal of all 3 ignition coils. Each coil contains an internal driver circuit. The driver circuit switches the primary current on for a given time period (dwell), and then switches it off causing the collapse of the coil's magnetic field which creates a spark. The Crank Position Sensor reads the encoder tooth pattern on the flywheel which allows the PCM to monitor the position of the crankshaft while the engine is running. At the proper time for ignition spark, the PCM sends a digital signal to the coil driver commanding the driver to dwell and then provide spark. When the engine is operating at lower RPM, this process is repeated in quick succession to provide a multi-strike spark for each combustion event. The number of strikes per event is varied depending on RPM and load requirements. The spark plug features an extended protrusion into the combustion chamber and platinum tips on both the center and ground electrode.

Note: Ignition load test was not operational until PCM part number 885557 047 for 115 HP, 885557046 for 90HP and 885557001 for 75 HP introduced late 2004.

3 Cylinder 1.5L Ignition Coil Schematic





Notes

Electronic Control Module (ECM)

ECM/PCM IDENTIFICATION

ECM - “Electronic Control Module”

PCM - “Propulsion Control Module”. PCM has all functions of ECM, including the ability to handle Digital Throttle and Shift Functions.

ECM/PCM DESIGNATIONS

Non-555 OptiMax - This is the original ECM used on Optimax engines 1998-2000 MY. Cannot accept CAN for Smartcraft operation. Smartcraft gauges utilitized on 2000 MY ran through the 5 pin tach harness.

555 or Triple Nickel ECM/PCM - Started with 2001MY Optimax engines and later installed on V-6 EFI (2002MY). This ECM/PCM has CAN capability for Smartcraft. PCM introduced in 2003 MY for introduction of DTS on 225 Optimax. This ECM/PCM has one 5 volt power source identified as PWR 1 on scan tool.

PCM 03/038 - Introduced for 2004 MY. Includes all functionality of 555 style PCM/ECM. Major change is the addition of 5 volt power circuit (as soon as the engine changes to the 14-pin harness). Now the engine sensors have a dedicated 5 volt reference circuit while DTS/Smartcraft has a dedicated 5 volt reference circuit. PWR 1 and PWR 2 now displayed on scan tool.

The ECM requires 8 VDC minimum to operate. If the ECM should fail, the engine will stop running. The inputs to the ECM can be monitored and tested by the Digital Diagnostic Terminal 91-823686A2 using adaptor harness 84-822560A5. The ECM performs the following functions:

- Calculates the precise fuel and ignition timing requirements based on engine speed, throttle position, manifold pressure and coolant temperature.
- Controls fuel injectors for each cylinder, direct injectors for each cylinder and ignition for each cylinder.
- Controls all alarm horn and warning lamp functions.
- Maintains correct idle speed in or out of gear.
- Monitors oil pump solenoid coil.
- Monitors reserve oil tank level.
- Monitors air compressor temperature.
- Monitors engine temperature via coolant sensor.
- Monitors atmospheric pressure via MAP sensor
- Monitors shift interrupt via shift switch, above 600 RPM by reducing engine power.
- Supplies tachometer signal to gauge
- Controls RPM limit function (caused by TPI fault, overheat, overspeed or power reduction)
- Records engine operating history
- Records sensor fault history

Flywheel

The teeth under the flywheel ring gear provide engine rpm and crankshaft position information to the ECM through the crank position sensor.

Notes

Notes

Crank Position Sensor

Senses teeth located on flywheel under ring gear. Supplies the ECM with crank position information and engine speed. If sensor should fail, the engine will stop running.

Throttle Position Sensor (TPS)

Two (2) Throttle Position Sensors are used in conjunction with one another. If one sensor should fail, the dash mounted CHECK ENGINE light will light and the warning horn will sound. RPM will be limited to 3000 rpm. If both TPS's should fail, rpm will be reduced to idle by the ECM. TPS settings are not adjustable. TPS settings can be monitored with the Digital Diagnostic Terminal through the ECM.

NOTE: 2000 & Newer model year engines use only one TPS.

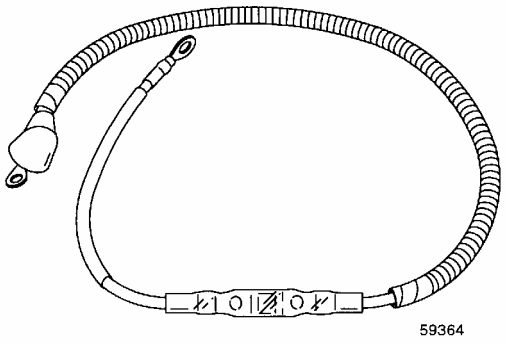
Charging System Alternator

Battery charging system is contained within the belt driven alternator, including the regulator. At cranking speeds, electrical power for the engine is provided by the boat battery – minimum recommended size is 750, or 1,000 MCA, cold cranking amperes. Above 550 RPM, all electrical power is provided by the alternator. Should engine rpm drop below 550 RPM, the alternator is not capable of providing sufficient output and the battery becomes the primary source of electrical power. Once the engine is running and rpm is 650 or higher, the engine will continue to run should the battery become shorted or disconnected.

Alternator output (when hot) to the battery @ 2000 RPM is approximately 52 - 60 amperes.

FUSIBLE LINK - 2003 MY AND UP

- A 100 amp fuse (Fusible link) is installed in the alternator power outlet wire, that runs from the alternator to the starter solenoid.
- Fuse will prevent damage to alternator and output wire, if battery connections are reversed by mistake.
- The fuse is part of the wire so the complete wire must be replaced if the fuse has an open circuit.



a) 100 Amp Fuse

Temperature Sensor

Three (3) temperature sensors (2 on 1.5L models) are used to provide cylinder head temperature information to the ECM. One sensor is mounted in each cylinder head and one in the air compressor cylinder head. The ECM uses this information to increase injector pulse width for cold starts and to retard timing in the event of an over-heat condition.

An ohms test of the temperature sensor would be as follows:

Insert digital or analog ohmmeter test leads into both TAN/BLACK sensor leads. With engine at temperature (F°) indicated, ohm readings should be as indicated ±10%.

Manifold Absolute Pressure (MAP) Sensor

The ECM regulates fuel flow, in part, based on manifold absolute pressure (MAP). Drawing a vacuum on the MAP sensor will create a lean fuel condition.

Air Temperature Sensor

The air temperature sensor is mounted on the intake manifold. The ECM regulates fuel flow, in part, based on manifold air temperature. As air temperature increases, the ECM decreases fuel flow.

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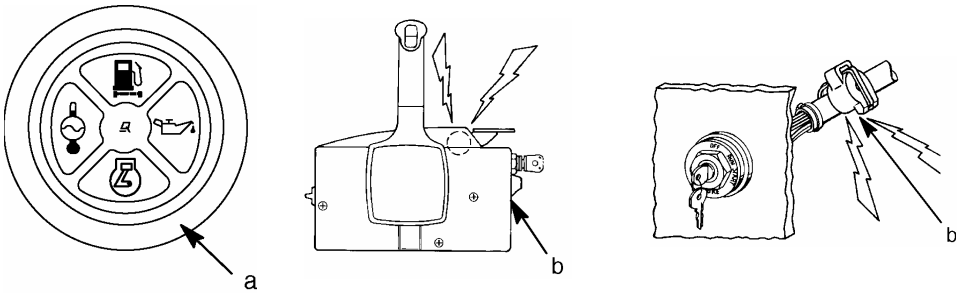
1998/99 Warning System

The outboard warning system incorporates warning light gauge and warning horn. The warning horn is located inside the remote control or is part of the ignition key switch wiring harness.



When the key switch is turned to the ON position, the warning lights and horn will turn on for a moment as a test to tell you the system is working.

Tip: The 4 Function Gauge can only be used with 2000 MY and prior products (Non-555 ECM).

Warning System Signals

NOTE: The warning system signals which includes audible and visual indicator involving the horn and lights will identify the potential problems listed in the chart

Problem	Horn	Check Engine Light	Low Oil Light	Over Heat Light	Water In Fuel Light	Engine Speed Reduction Activated (approx. 3000 RPM)
Power Up/ System Check	Single Beep	Yes	Yes	Yes	Yes	No
Low Oil	4 Beep… 2 Minutes Off		Yes			No
No Oil Flow	Continuous Beep	Yes	Yes			Yes (Limits to 3000 RPM)
Over Heat	Continuous Beep			Yes		Yes (Limits to 3000 RPM)
Water In Fuel	4 Beep… 2 Minutes Off				Yes	
Over Speed	Continuous Beep					Yes (Activated at 5800 RPM)
Coolant Sensor Failure	No	Yes				
MAP Sensor Failure	No	Yes				
Air Temperature Sensor Failure	No	Yes				
Ignition Coil Failure	No	Yes				
Injector Failure	No	Yes				
Horn Failure	N/A	Yes				No
Battery Voltage too high (16V) or too low (11V) or very low (9.5V)	No	Yes				Yes – If battery voltage is less than 10.4V, RPM is reduced to 3000. If voltage is 9.5V or less, RPM is reduced to idle.
Over Heat Cyl. Head/Compressor	Continuous Beep			Yes		Yes
Throttle Sensor Failure	Continuous Intermittant Beep	Yes				RPM reduces to 3000 if 1 sensor fails. RPM is reduced to Idle speed only if both sensors fail

Notes

Guardian Protection System - All 2000 Models & Newer

The guardian protection system monitors critical engine functions and will reduce engine power accordingly in an attempt to keep the engine running within safe operating parameters.

IMPORTANT: The Guardian System cannot guarantee that powerhead damage will not occur when adverse operating conditions are encountered. The Guardian System is designed to (1) warn the boat operator that the engine is operating under adverse conditions and (2) reduce power by limiting maximum rpm in an attempt to avoid or reduce the possibility of engine damage. The boat operator is ultimately responsible for proper engine operation.

Guardian System Operation with Gauges

4 Function Gauge	System will sound warning horn and illuminate appropriate light on gauge.
SmartCraft Gauge	System will sound warning horn and display the warning message.

Guardian System Activation

Condition	Result
Engine Overheat	Engine power level can be reduced to any percentage down to an idle speed, if overheat condi-tion persists.
Air Compressor Overheat	2000 Model – engine power level can be reduced to any percentage down to an idle speed, if over-heat condition persists. 2001 Model – no power reduced.
Block Water Pressure Low	Engine power level can be reduced to any percentage down to a fast idle, if condition persists.
Throttle Position Sensor Failure	If the throttle position sensor fails or becomes disconnected, power will be limited to a maximum of approximately 4500 rpm. When the TPS is in the fail mode, the ECM will use the MAP sensor for a reference to determine fuel calibration.
Temperature Sensor (cylinder head and air compressor) Failure	If a temperature sensor should fail or become disconnected, power will be reduced by 25%.
Battery Voltage (too high or too low)	Battery voltage greater than 16.5 volts or less than 10.5 volts will result in engine output power being reduced. The higher or lower the voltage is outside of these parameters, the greater the percentage of power reduction. In an extreme case, power could be reduced to idle speed.
Oil Pump Failure	If the oil pump fails or an open circuit occurs between the pump and the ECM, engine power will be reduced to idle.

OptiMax Service Tips

Notes

1998/99 135/150, 2.5 LITRE

1998/99 200/225, 3.0 LITRE

The following Troubleshooting/Service tips have been accumulated over the past several months. These are not necessarily the only solution to the problem.

Shift Slide:

3.0 LITRE

There have been reports of the shift slide P/N 853968--1 being installed upside down, in the roller guide, this could result in hard shifting. The ribbed side of the slide should face down.

Main Power Relay

2.5 & 3.0 LITRE

On occasions dealers have diagnosed an electrical problem, to no output from the main power relay. The relay has been found to be good, there is battery voltage on both the PURPLE and RED leads, going to the relay, but the ECM is not allowing it to turn on. The YELLOW/PURPLE wire is a ground circuit in the ECM that allows the main power relay to close. If there is a fault in the kill circuit (BLACK/YELLOW) wire the ECM will not allow the main power relay to turn on. See DDT main power relay load test, page 128 of DDT Reference Manual.

Temperature Readings:

3.0 LITRE

The 3.0L power head has rubber water deflectors/dams in the water passages between the cylinders (see cooling system section 4B). If these deflectors/dams are not installed, the cylinder temperature will read 30 to 40 degrees higher on that bank of cylinders. Remove cylinder head and install water deflectors P/N 824857--2.

Fuel Supply Hose Restricted:

2.5 & 3.0 LITRE

Fuel restriction problems have been seen in two locations on Optimax product.

Where the fuel hose passes through the bottom cowl clamp, on both 2.5 and 3.0 Litre.

On the 3.0 Litre product, if excess fuel hose gets pushed into the bottom cowl, the pulse pump inlet fuel hose may kink at the lower formed 90 degree bend. This may not occur when the engine is first put into operation, it may occur some time later when the fuel hose becomes soft from heat and fuel.

Loose Fuse Holder

2.5 & 3.0 LITRE

If the DDT shows a fault on all 6 direct injectors, fuel injectors, or ignition coils, it is not likely that all 6 of these component have failed, make sure the fuse for that circuit is good and that it is making good contact with the fuse socket/connector.

2.5 & 3.0 LITRE

An engine that surges between 1200 and 2000 RPM may have a missing tracker valve spring. The fuel and air pressure may not indicate any problem and normally the engine will run good below and above this RPM range.

Fuel Injector Test

2.5 (1998 MODEL)

When doing the fuel injector load test, with the DDT, the sound from the # 4 & 6 fuel injectors may not be as loud or as many pulses as the other injectors. This is normal and should not be considered a problem or fault in the engines electrical system. The 1999 ECM software has corrected this condition.

Fuel Pressure (Pressure No Volume)

2.5 & 3.0 LITRE

There have been reports of a loss of top RPM. No warning lights or horns are indicated. The engine has symptoms that strongly indicate loss of fuel. Runs up to full RPM for a short time (seconds) and then drops down in RPM, or may not get to full RPM at all. The pressure gauge may indicate good fuel & air pressure 90 & 80 psi. To confirm that the fuel supply is adequate, restrict/pinch off the fuel return hose between the fuel cooler and the VST. This test should be performed at WOT. When restricted the fuel pressure should rise quickly to above 110 psi. If not, there is some type of fuel supply problem.

Weak Spark (Ignition Coil)

2.5 & 3.0 LITRE

The ignition coil used on the Optimax product has a magnet inside. If the magnet is installed up side down, the engine may run rough or misfire. The ohm value will be correct and the DDT will likely not detect a fault. Usually the problem can be detected by performing the cylinder drop test with the DDT at the RPM that the engine is running rough or misfiring. Then switch the coil to a different cylinder and test again. NOTE: The faulty ignition coil may also be hot to the touch.

Notes

Notes

Alternator:

3.0 LITRE

There have been three reports of burned/melted alternator RED wires. This can be caused by the wire being routed incorrectly and chaffing through and shorting to ground, or the battery cables have been reversed. If the cables have been reversed the RED wire will be burned/melted the full length of the wire. If wire is shorted, it will be burned/melted between the short and connection to the starter solenoid.

Alternator Belt:

2.5 LITRE

When the rubber mounted alternator bracket is installed as per Service Bulletin 98-8, the belt tensioner pulley may hit the flywheel. If the belt was at the short end of the tolerance is when this is likely to occur. Install new alternator belt P/N 828507--4, which is .400 longer and will provide proper clearance.

Salt In Compressor Inlet

3.0 LITRE

In salt-water areas, if the cooling system is not flushed regularly, salt could build-up in some of the smaller water hose fittings.

On the 3.0 Litre the salt builds up in the inlet water fitting on the air compressor head, due to the extra heat in this area.

Direct Injector Stuck:

2.5 & 3.0 LITRE

When a direct injector sticks the corresponding fuel injector will continue to function. This will cause excess fuel to accumulate in the air side of that rail, affecting the fuel calibration of those cylinders. Example: If the number 1 direct injector stuck closed, the number 3 & 5 cylinder will run rich. This will result in a loss of engine RPM or power greater than expected with the loss of one cylinder. If a Direct injector is mechanically stuck closed, it will not show as an electrical fault on the DDT.

Twin Pressure Gauge:

2.5 & 3.0 LITRE

Part number of the twin pressure gauge used on Optimax product has su

The new gauge has improved schrader valve connections (screw on type). The clip on style connectors have been removed and screw on connectors with quick disconnects have replaced them. The new gauge will also have FUEL & AIR marked on the gauge manifold. The fuel side will include a check valve at the connector, to retain fuel in the gauge when gauge is disconnected from engine.

To up-grade the current gauges in use, there will be an adapter kit available. Two kits are required for the twin pressure gauge.

- ADAPTER KIT P/N 91-803804A2

Low Pressure Electric Fuel Pump System Failure

2.5 LITRE

If the low pressure pump, or the electrical connection to the pump fail, the engine will start and run well at lower RPM. As the engine RPMs are increased (somewhere above 3000) the engine may stall out, or not reach full RPM. Fuel and air pressure will be lower then normal. Another symptom, if the pump outlet fitting (upper) is very warm (too hot to touch), the pump itself is failing.

Incorrect Grommet (Air Handling Assembly)

2.5 LITRE

There are two different grommets used on the Air Handling Assembly (AHA). The grommet used on the 135 HP has a (1 5/8 in.) opening, which restricts air flow into the air plenum. The 150 HP grommet has no restriction at all, and only functions as a grommet for correct fit of the flywheel cover. If a 150 HP grommet is incorrectly installed on a 135 HP, it will result in poor engine acceleration due to incorrect fuel calibration. Symptoms are normally a surge and shake over 3000 RPM, if the operator pulls back on the throttle the engine will smooth out. Note: To reach maximum RPM, the engine can be throttled slowly through this range. The Digital Diagnostic Terminal (DDT) will not indicate any type of failure or fault.

Hard Starting

2.5

We have received some reports of hard starting 135/150 HP Optimax/DFI engines. To date we have found 3 reasons (Listed below) for this condition.

1) Incorrect battery (low amp rating, or deep cycle battery used as cranking battery.
2) Incorrect engine set-up, throttle cable, or roller to cam setting.
3) ECM calibration. We have found that the early ECM calibration may be to lean for some engines. Refer to S/B 98

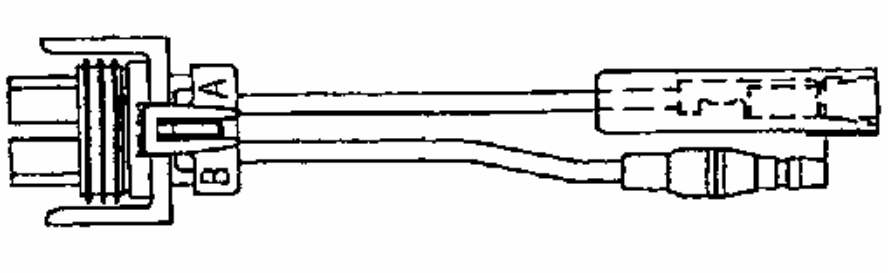
Notes

Notes

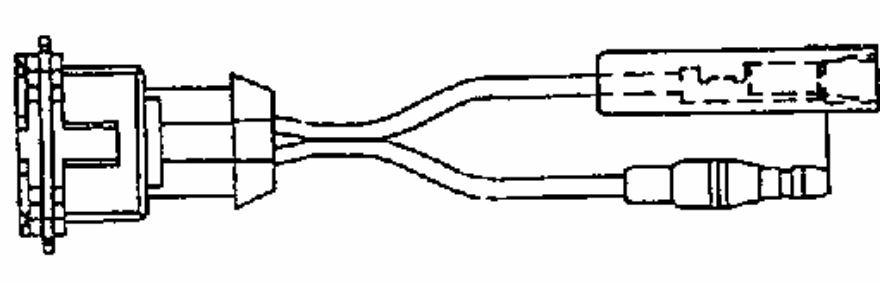
Harness Replacement Ends

2.5 & 3.0 LITRE

Service replacement harness connectors for the Optimax fuel injector, Direct injectors, TPS and Crankshaft Sensor are now available. This will allow the dealer the option to repair the engine harness rather than replacing it complete. Both of these connectors have been prone to shipping damage. Connector kit will include required connectors to hook into the main engine harness.



Connector Direct Injector P/N 84-858781A2



Connector Fuel Injector P/N 84-858780A2

Connector TPS P/N 84-878073A1

Connector Crankshaft Sensor P/N 84-878074A1

Note: There are more connectors then listed please reference current parts catalogue for part numbers.

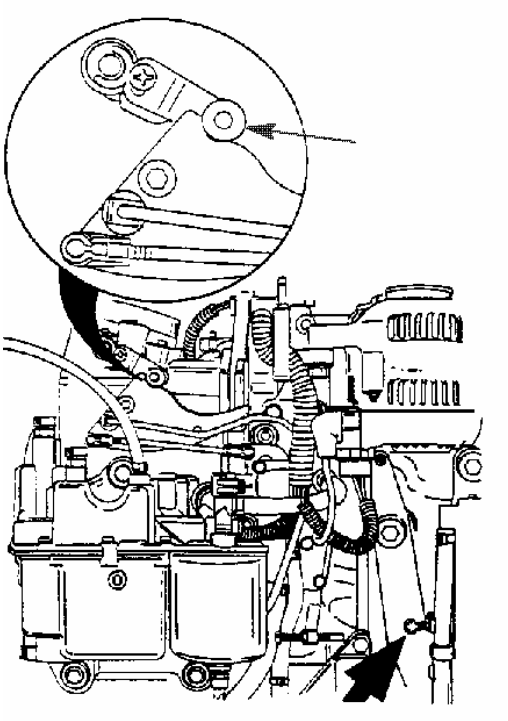
False Throttle Position Sensor Failures

2.5 LITRE

If the Throttle Position Sensors (TPS's) are out of the intended operating range, or change value at the idle position, after the engine is started, the Electronic Control Module (ECM) will sense that the (TPS/s) has failed. The warning horn will sound, check engine light will illuminate, DDT will indicate failed TPS/s, and the engine may go into power reduction. If TPS failures codes occur check the following.

- Check throttle cable adjustment, the throttle stop screw on throttle aria must be against the throttle stop on the cylinder block when the engine is started. Pre-load the throttle cable barrel one or two turns if necessary.
- When starting the engine make sure the operator is not pushing on the throttle (if foot throttle is used) or advance the throttle only on the control box.
- Check the throttle cam to roller adjustment. If the roller is not down in the pocket/valley area on the cam, there is a tendency for the roller to ride up or down on the cam, this in turn causes the TPS link arm to push/pull on the TPS lever, changing the valve.
- Perform heat test on TPI, replace any units which fail test.

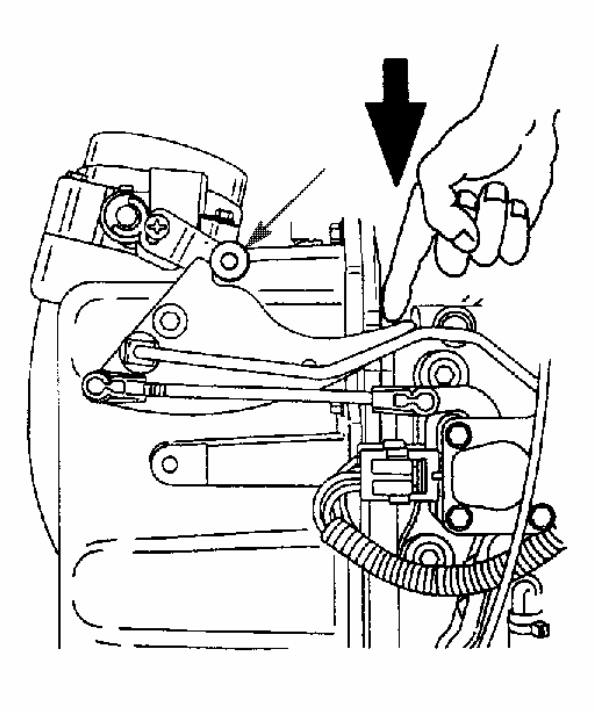
Correct Cam to Roller Setting (2.5L)



Notes

Notes

Incorrect Cam to Roller Setting



Throttle Position Sensor (TPS) Troubleshooting

If the throttle position sensor(s) are out of the intended operating range when the engine is started, the Electronic Control Module (ECM) will sense that the Throttle Position Sensor (TPS) has failed. The warning horn will sound, check engine light will illuminate DDT will indicate failed TPS and the engine will go into RPM reduction. When the engine is started, the throttle arm on the engine must be against the throttle stop screw.

- Check throttle cable adjustment. The throttle stop screw on the throttle arm must be against the throttle stop on the cylinder block when the engine is started. Pre-load the throttle cable barrel 1 or 2 turns if necessary.
- Verify driver is not pushing on throttle (if foot throttle is used) or activating the throttle only on the control box.
- Check throttle cam to roller adjustment. If the roller is not down in the pocket/valley area in the cam, there is a tendency for the roller to ride up or down on the cam which causes the TPS link arm to push/pull on the TPS lever resulting changing values.
- Make sure the roller doesn't have any flat spots or is egg shaped if so replace.
- Make sure the throttle link rod is not loose or have excessive play this could result in false TPS voltage readings.
- Heat or pressure test the TPS.

HEAT TEST

With engine at idle, heat the TPS (with a hot air gun) below the electrical connection until warm to the touch. Watch for any one or a combination of the following symptoms:

- RPM change
- Check engine light illumination
- Momentary warning horn signal
- TPS voltage value change (1/2 volt) on DDT

NOTE: Excessive heat will damage TPS.

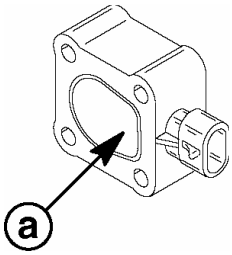
PRESSURE TEST

IMPORTANT: When testing TPS voltage, do not move the drive mechanism (rotor/wiper).

1) Connect DDT and rotate the key to the “ON” position.
2) Set DDT to read TPS voltage; expand the screen to show Now/Min/Max.

NOTE: Test accuracy is improved when TPS is at its lowest voltage reading; this may be idle or WOT depending on model year.

3) Clear the minimum/maximum values on the DDT - press the “0” button.
4) Watch the DDT reading while pressing below the electrical connection point on the TPS cover.



a) Press on Cover Below Electrical Connection

5) Voltage reading should change:

- Less than a couple of digits (i.e. 1.90 v to 1.92 v)

NOTE: *Version 5.0 cartridge gives 3 decimal point (millivolts) accuracy if below 1 volt.*

- Less than 10 millivolts (i.e. 0.293 v to 0.285 v)
- Replace any TPS that fails either test.

Notes

Notes

Engines Stalling On Flushing Attachment

2.5 LITRE

When running, on a flushing attachment some engines may stall when the DDT miss-fire test is performed. These same engines have run well when used under normal boating conditions.

225 Revised Fuel Calibration

Some early 1999, 225 HP, OptiMax engines may experience hard starting, rough idle, and stalling when shifted into gear. There is now a revised ECM calibration to correct this problem. Before replacing the ECM, MAKE SURE all systems are in good operating condition. To confirm that the fuel calibration is the problem, disconnect the (three) wire (starboard) head temperature sensor when the engine is cold. If the engine now starts correctly, it is likely the new ECM (P/N 857127A8) calibration will resolve the problem. Contact the service department for a pre-authorization.

Worksheet Part Numbers

OptiMax DDT Data Worksheet 90-858879

SmartCraft Data Worksheet 90-881929--1

OptiMax DDT Data Worksheet - P/N 90-858879

Dealer Name:	Engine S/N:
Dealer Number:	Engine Type:
Technician Name:	ECM Part Number:
Date:	DDT Software Version:

Total Run Time		
0000-0999		
1000-1499		
1500-2999		
3000-3999		
4000-4999		
5000-5999		
6000+		
RPM LIM CNT		
BREAL LN Min.		
OVER TMP Sec		
Ignition Err		
Cyl 1		
Cyl 2		
Cyl 3		
Cyl 4		
Cyl 5		
Cyl 6		
Injector Err		
Cyl 1		
Cyl 2		
Cyl 3		
Cyl 4		
Cyl 5		
Cyl 6		
Pump Err		
OIL PMP		

Sensor Err		
CTS		
CTP		
ACT		
MAP		
TPI 1		
TPI 2		
AIR		
TRIG		
BPSI		
Switches Err		
LOW OIL		
H_2O		
Misc. Err		
BAT		
PWR 1		
PWR 2		
PRLY		
LAMP		
HORN		

WOT RPM		

Description of Problem:

OptiMax DDT Data Worksheet - P/N 90-858879

Dealer Name:	Technician Name:
Dealer Number:	Engine S/N:

#1 Data Monitor	NOW:	Min:	Max:	Notes
ENGINE RPM				
TPI 1 VOLTS				
TPI 2 VOLTS				
BATTERY VOLTS				
PWR 1 VOLTS				
PWR 2 VOLTS				
COOL TMP STB				
COOL TMP PRT				
MAP PSI				
AIR TMP				
TRIGGER ERR				
TIME TO OIL				
OIL INJ CNT				
AIR COMP TMP				
BLOCK PSI				

#2 Data Monitor	NOW:	Min:	Max:	Notes
ENGINE RPM				
TPI 1 VOLTS				
TPI 2 VOLTS				
BATTERY VOLTS				
PWR 1 VOLTS				
PWR 2 VOLTS				
COOL TMP STB				
COOL TMP PRT				
MAP PSI				
AIR TMP				
TRIGGER ERR				
TIME TO OIL				
OIL INJ CNT				
AIR COMP TMP				
BLOCK PSI				

Smartcraft Data Worksheet - P/N 90-881929--1

Dealer Name:	Engine S/N:
Dealer Number:	Engine Type:
Technician Name:	ECM Part Number:
Date:	DDT Software Version:

Fault Seconds	Engine #1	Engine #2	Run History	Engine #1	Engine #2
BATT VOLT HIGH			RUN TIME HR		
BATT VOLT LOW			RPM 0-749		
BLOCK PRESS LOW			750-1499		
COMP OVERHEAT			1500-2999		
ETC MOTOR OPEN			3000-3999		
ETC MOTOR SHORT			4000-4499		
FUEL P INPUT HI			4500-4999		
FUEL P INPUT LO			5000-5499		
GUARDIAN			5500-6249		
KNOCK SENS1			6250+		
KNOCK SENS2			BREAK-IN LEFT		
OIL PSI STR			RPM LIMIT Sec		
OIL REMOTE SRT			GRD LIMIT Sec		
OIL RESERVE STR			ACT TEMP Sec		
MAP INPUT HI			BLOCK PSI Sec		
MAP INPUT LO			CTS TEMP Sec		
MAP IDLE CHECK			CTP TEMP Sec		
OIL PUMP			LOW OIL Sec		
OVERSPEED			OIL PMP Sec		
PORT OVERHEAT			**Boat Information**		
STAR OVERHEAT					
WARNING HORN			WOT RPM		
H2O IN FUEL			Propeller Type		
	#1 #5		Propeller Size		
LED INDICATORS	#2 #6		Boat Type		
ILLUMINATED	#3 #7		Boat Length		
	#4 #8		Weather Condition		

SmartCraft Data Worksheet - P/N 90-881929--1

Dealer Name:	Engine S/N:

FREEZE FRAME FAULT BUFFER DATA

FAULT ID	Fault Buffer 0	Fault Buffer 1	Fault Buffer 2	Fault Buffer 3	Fault Buffer 4	Fault Buffer 5	Fault Buffer 6	Fault Buffer 7	Fault Buffer 8	Fault Buffer 9
BREAK-IN										
BARO PSI										
BATT VOLTS										
BLOCK PSI										
BOAT SPEED										
AIR TEMP F										
COOL TEMP F										
DEMAND %										
ENGINE RPM										
ENGINE STATE										
FPC TOTAL										
FREQ COUNTER										
FUEL LEVEL %										
SHIFT										
LAKE/SEA TEMP F										
LOAD %										
MPRLY										
MAP PSI										
OIL LEVEL %										
PORT TAB POS										
AVAILABLE PWR %										
RUN TIME										
STAR TAB POS										
TPS %										
TRIM POS										
COOL TEMP STB F										
COOL TEMP PRT F										

What was the engine speed when the failure occurred? _____

How was the engine being operated before the failure?

1) Steady RPM
2) Decelerating
3) Accelerating
4) Extended Idle

SmartCraft Data Worksheet Fault ID Description

Notes

BREAK IN

- Engine is still within oil break-in clock

BARO PSI

- The barometric pressure when the fault occurred

BATT VOLTS

- The battery voltage when the fault occurred

BLOCK PSI

- The engine block pressure when the fault occurred

BOAT SPEED

- Boat speed when the fault occurred

AIR TEMP 0F

- The engine temperature when the fault occurred

COOL TMP F

- The primary (CTS) coolant temperature when the fault occurred

DEMAND %

- The demand % (TPI%) when the fault occurred

ENGINE RPM

- The engine RPM when the fault occurred

ENGINE STATE

- The engine state when the fault occurred

FPC TOTAL

- The calibrated fueling level when the fault occurred

FREQ COUNTER

- The number of times the fault occurred. 0=1 occurrence, 1=2 occurrences

FUEL LEVEL %

- The main fuel tank level % when the fault occurred

SHIFT

- The engine was in gear (or neutral) when the fault occurred

LAKE/SEA TMP F

- The temperature of the lake/sea water when the fault occurred

Notes

SmartCraft Data Worksheet Fault ID Description (Cont.)

LOAD %

- The engine load % when the fault occurred

MPRLY

- A value of zero indicates there was no request made to activate the main power relay. A value greater than zero indicates that the main power relay was active.

MAP PSI

- The MAP pressure when the fault occurred

OIL LEVEL %

- The main oil tank level % when the fault occurred

PORT TAB POS

- The position of the port trim tab when the fault occurred

AVAILABLE PWR %

- Available Engine Power % when the fault occurred

RUN TIME

- The time at which the fault occurred (ECM run time)

STAR TAB POS

- The position of the starboard trim tab when the fault occurred

TPS %

- The TPI % (Demand %) when the fault occurred

TRIM POS

- The trim position when the fault occurred

COOL TMP STB 0F

- The starboard coolant temperature sensor reading when the fault occurred

COOL TMP PRT 0F

- The port coolant temperature sensor reading when the fault occurred

SmartCraft Data Worksheet

Dealer Name:	Engine S/N:
Dealer Number:	Engine Type:
Technician Name:	ECM Part Number:
Date:	DDT Software Version:

Data Monitor - OptiMax

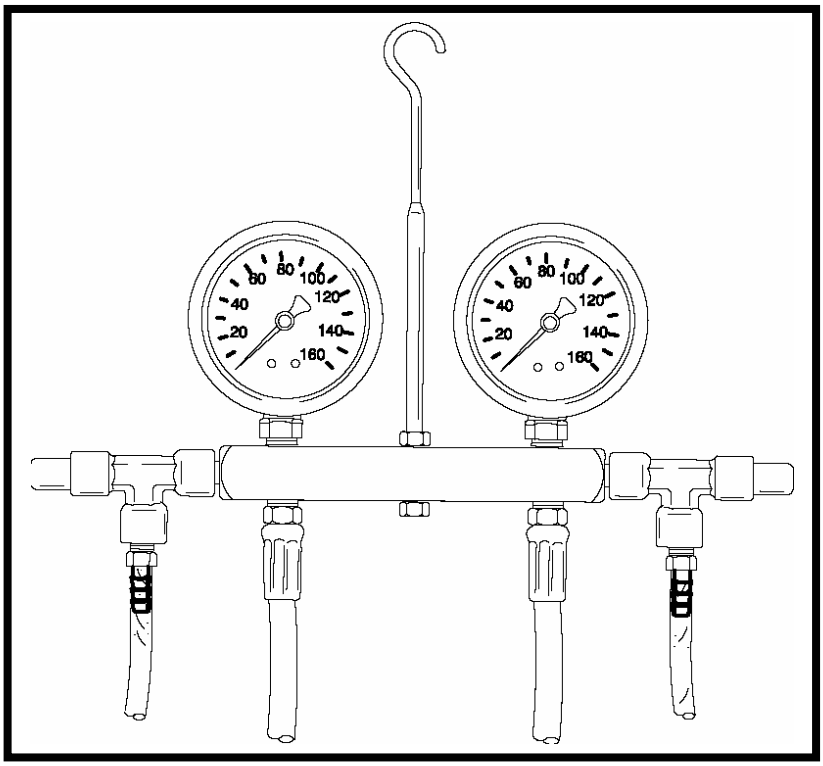
ENGINE #	IDLE	1500 RPM	3000 RPM	NOTES:
ENGINE RPM				
TPI 1 VOLTS				
BATTERY VOLTS				
PWR 1 VOLTS				
COOL TMP STB (F)				
COOL TMP PRT (F)				
MAP PSI				
AIR TMP (F)				
BLOCK PSI				
OIL INJ CNT				
TPI %				
AIR COM TMP (F)				
OIL LEVEL				
FUEL LEVEL				
AVAILABLE PWR %				
SHIFT				
TRIM				
PITOT				
PADDLE WHEEL				
LAKE/SEA TMP (F)				
SPARK ANG BTDC				
FPTC TOTAL oz				

SmartCraft Data Worksheet

Dealer Name:	Engine S/N:
Dealer Number	Engine type:
Technician Name:	ECM Part Number:
Date:	DDT Software Version:

ENGINE #				
ENGINE RPM				
TPI 1 VOLTS				
BATTERY VOLTS				
PWR 1 VOLTS				
COOL TMP STB (F)				
COOL TMP PRT (F)				
MAP PSI				
AIR TMP (F)				
BLOCK PSI				
OIL INJ CNT				
TPI %				
AIR COM TMP (F)				
OIL LEVEL				
FUEL LEVEL				
AVAILABLE PWR %				
SHIFT				
TRIM				
PITOT				
PADDLE WHEEL				
LAKE/SEA TMP (F)				
SPARK ANG BTDC				
FPTC TOTAL oz				

Section 8 - Tools For OptiMax



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- Schrader Valve Tee - P/N 22-849606 5
- Purge Valve - P/N 91-804706 5
- O-Ring - P/N 25-803803 5
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- DTS CAN Connector Harness – 84-892663 15

Tool Supplier Contact Information

Cole-Parmer	800-323-4340, or 847-549-7600
SPX-OTC	616-792-0088
Blue Point	800-547-5740
Electronic Specialties	815-675-2905
Kent Moore	800-345-2233
Bob Kerr	800-867-4807
Specialty Motors	800-426-8644
Stevens Instruments	847-336-9375
Yardarm Products	800-547-5243
Flaherty Co.	920-921-7680

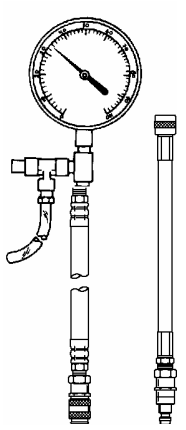
Notes

Tools for OptiMax Repair

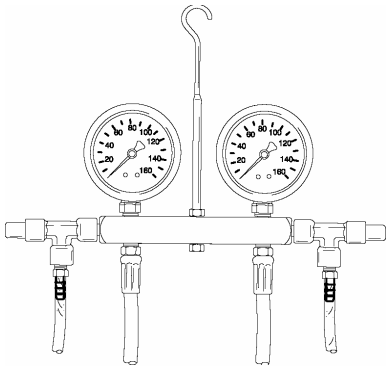
Single Fuel/Air Pressure Gauge 160 PSI – 91-16850A7

Note: To convert 100 psi gauge 91-16850A1 to 160 psi gauge, order upgrade 91-16850--1.

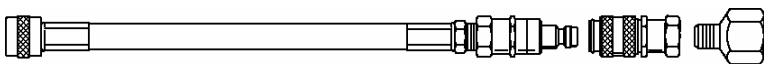
Dual Fuel/Air Pressure Gauge 160 PSI - P/N 91-881834A1



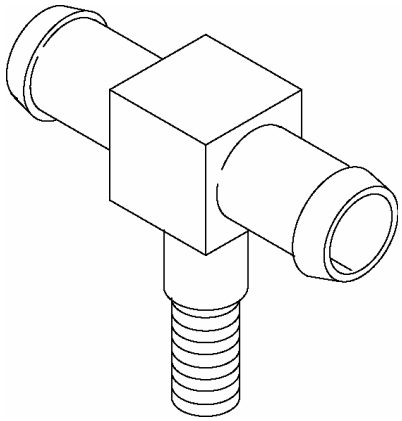
NOTE: *To convert older single and dual pressure gauges with quick-disconnect fittings to latest screw on fittings order hose kit 91-803804A2. Kit contains one replacement hose, dual gauge assembly required two kits.*



Adapter Kit - P/N 91-803804A2

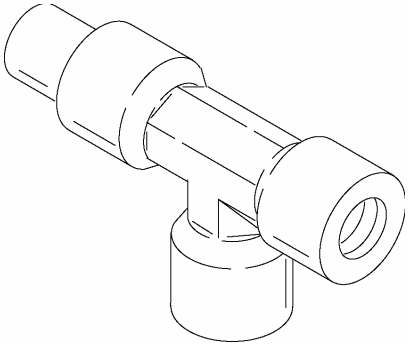


Schrader Valve Tee - P/N 22-849606

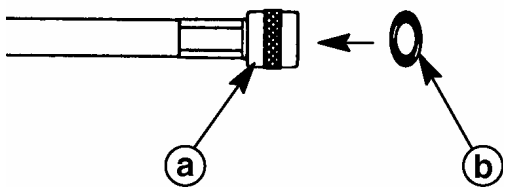


Purge Valve - P/N 91-804706

Service replacement pressure release valve is now available, for the twin pressure gauge P/N 91-852087A1/A2/A3 or the single pressure gauge P/N 91-16850, A1/ A2/A3/A5/ & A7 versions.



O-Ring - P/N 25-803803

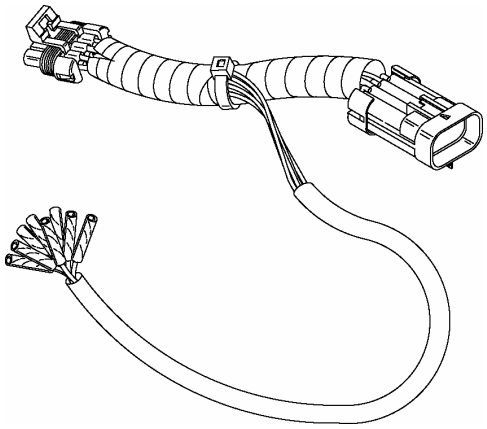


Replacement O-ring for screw on style schrader valve gauge connections. Seals off pressure between the schrader valve on engine and gauge connection.

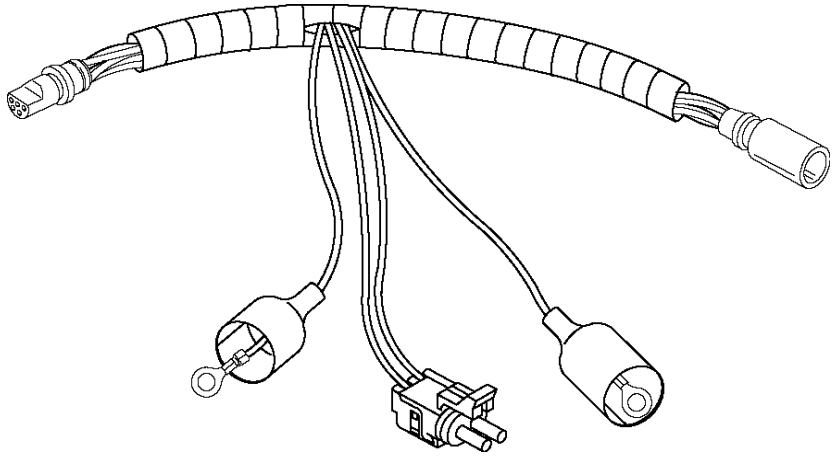
Notes

Notes

Digital OptiMax Sensor Test Harness - P/N 91-875233A2



DDT Test Harness (5 Pin Digital Adapter) - P/N 91-875232A1



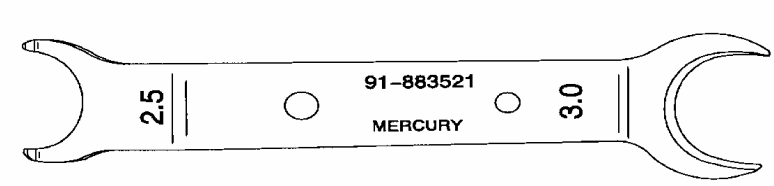
Two wire extension harness, OptiMax data cable. Extends DDT adaptor harness to a length of 15 ft.

DDT Extension Harness - P/N 84-822560T11

Remote Key Switch - P/N 15000A7

OptiMax Wiring End Seal Kit - P/N 91-881814A1

Direct Injection Removal Tool - P/N 91-883521



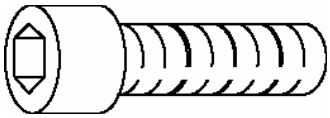
Pressure Gauge Extensions - P/N 91-881835

Notes

Notes

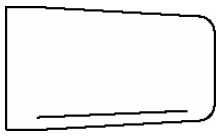
Oil Syringe - P/N 91-803976T

Screw (5 mm x 25 mm) (2 each) - P/N 10-40073-25

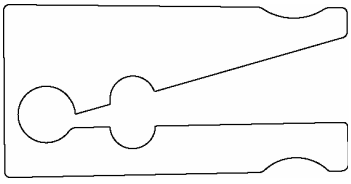


Flat Washer (2 each)

Seal/Teflon Ring Installation Tool - P/N 91-851980-3



Seal/Teflon Ring Sizing Tool - P/N 91-851980-2



DDT Carrying Case P/N 804805

Service Tachometer DMT 2000 - P/N 91-854009A3

Service Tachometer DMT 2004 - P/N 91-892647A01

DMT 2000A and 2004 Accessories

INDUCTIVE PICK-UP - P/N 91-854010-1

TEMPERATURE PROBE – P/N 91-854011-1

REPLACEMENT FERRITE CORE – P/N 91-_____

INTERFACE MODULE – P/N 91-854013-1

HARD CARRYING CASE – P/N 91-854014-1

USER'S GUIDE – P/N 90-854015-1

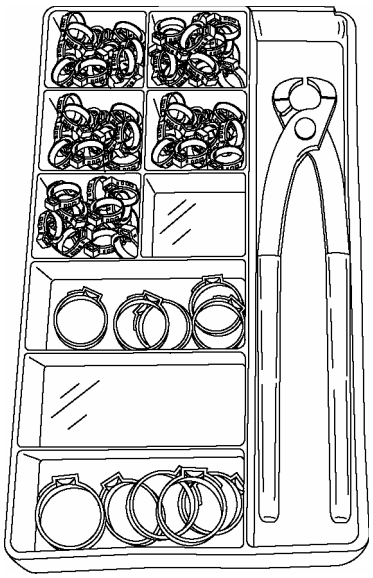
TEST LEADS – P/N 91-80265

CLAMP-ON CURRENT PROBE – P/N 91-802650-1

Notes

Notes

Clamp Tool Kit - P/N 91-803146A2



Regulator Installation Tool - P/N 91-889431